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ECONOMICAL TRAIN OPERATION.

BY G. R. HENDERSON.

PART II.

COST OF OPERATION.

It has been indicated in Part I. how the different expenses connected with train operation should be grouped and detailed in order to make a comprehensive study of the economy to be derived from various speeds and loads, and it now remains for us to apply this data to the different schedules so as to determine the relative cost of movement. We know at once that the profile of a division will greatly affect not only the rating of the engine but the cost of transportation, and as there may be an unlimited variety of profiles, we must arbitrarily select some specific cases for our investigation. Let us first assume an operating division 150 miles in length, the profile of which is a uniformly 1 per cent. up grade in the direction of prevailing traffic. It is true that the engines, and perhaps empty cars, must be brought down the hill, but in this case little fuel will be used, the speed should undoubtedly be as great as safety will permit, depending upon alignment, etc., and the trains should be as long as can be handled without danger. The down hill work is evidently not one requiring much study, as the equipment must be brought back, as well as the crews, and the longest trains and the highest speeds at which it is practicable to do this will give us the greatest economy, as well as the quickest return of the rolling stock to profitable use. The up grade work, however, requires a thorough investigation in order to determine the method of operation which will produce the maximum efficiency and the minimum cost, and in order to obtain a complete comparison we will consider the engine so loaded that the best running time that it can make is 5, 10, 15, 20 and 25 miles an hour. From Fig. 1 (in Part I.) we found that the maximum gross weight of train possible at these speeds is 1,600, 1,570, 1,240, 960 and 750 tons respectively (the last value is found by calculation: 21,000 lbs. A. T. F. ÷ 28 lbs. per ton grade and speed resistance, or 20 + 8, which gives us 750 tons), or 1,450, 1,420, 1,090, 810 and 600 tons back of the tender, allowing 150 tons for weight of engine and tender as we have already assumed. Now these latter values, multiplied by the distance, 150 miles, give us the ton mileage of each trip, including cars and loading. In order to show clearly the results of the calculations in each step of the investigation, table A is constructed, by setting down first the values already obtained on lines 1, 2, 3 and 4.

As a certain time is always spent upon side tracks waiting for trains, etc., we have allowed 20 per cent. in addition to the running time, and line 5 shows the time between terminals, while line 6 gives the average speed, including layouts. It will be considered that no fuel is used while standing upon side tracks, and while this is not strictly true, yet the amount is relatively small; and besides, it will be independent of the tonnage or the running speed, so that it may be omitted without sensible error; moreover, it cannot well be estimated.

The value of "a" can be determined from Fig. 1 as follows: At 5 miles an hour and a total train weight of 1,600 tons, we find that 700 pounds of coal per mile would be consumed, because the point intersected by the 5-mile an hour line and the 1,600-ton curve is also intersected by the 700-pound per mile curve; so for the trip we should have 150 miles × 700 lbs. = 105,000 lbs. of coal, as set down on lines 7 and 8. In the same manner we see that 1,570 tons, gross, at 10 miles an hour will require 800 tons per mile; the other quantities are found in the same way, completing line 7. At our supposed price of $2 a ton, the coal for the trip would cost the amounts set down in line 9.

As seen in Part I., the other locomotive supplies were taken at 1.5 cents per mile, or for 150 miles, $2.25 for the trip; train supplies being considered at the same rate, lines 10 and 11 both show the same amounts throughout. Thus lines 9, 10 and 11 correspond to cost items a, b and c, under the general caption of "Supplies."

Line 12 gives the amount of repair charges (and renewals) to the engine for the trip, being based on our derived rate of 8 cents per 1,000 ton miles, the latter being taken from line 4 of the table; thus 217.5 thousand ton miles × 8 cents = $17.40. Line 13 shows the same for the cars in the train. These two lines 12 and 13 cover cost items d and e of "Repairs."

We must now calculate the cost of service or wages, items f, g and h. Commencing with the enginemen (engineer and fireman) the combined rate is $7 per 100 miles or less, or 7 cents a mile if over 100 miles, with overtime at 70 cents an hour. For the first schedule the average speed between terminals is only 4.2 miles an hour, so the men will be entitled to 36 hours × 70 cents = $25.20, as given in line 14. The second schedule is 3 hours (18 — 15 = 3) over the schedule speed allowance, so the same rate would apply, viz., 70 cents an hour, or $12.60 for the trip. On the remaining three schedules, however, no overtime is earned, and the rate of 7 cents a mile applies, or 150 × 7 = $10.50.

The pay of the trainmen is worked up in a similar manner, allowing for the conductor and two trainmen, or a combined rate of 3.45 + 2.3 + 2.3 = 8.05 cents per mile or 80.5 cents per hour. The first two schedules will be on the hour basis as before, and the last three on the mileage basis, and the cost is shown by line 15.

The roundhouse labor is set down as $2 each trip on line 16, in accordance with the decision in Part I.

Line 17 gives the interest charges at 10 cents an hour, it being assumed that a lay-over of 5 hours is necessary each trip, for ordinary care of the engine. If the crews need rest, this time of idleness would be increased, but it can hardly be less than the period stated. By adding 5 hours to the time between terminals (line 5) we obtain the period on which to figure the

interest. Thus in schedule 1, $36 + 5 = 41$ hours total per trip and turn, and at 10 cents an hour $= \$4.10$. This corresponds to item "i."

By summing up lines 9 to 17 inclusive we have the cost of the trip, as far as these special and immediately concerned charges are affected, as explained in Part I. This has been done in line 18. If we now divide the values in line 18 by the ton miles made per trip, as given in line 4, we shall obtain the cost per ton mile, which is reduced in line 19 to the rate per 1,000 ton miles as this is a more convenient figure. Again if we take the time which is used in making a trip and its lay-over of 5 hours, and divide by it the number of hours in a month, we obtain the number of trips which could be made in this period, and this multiplied by the ton mileage of each trip gives the hauling rate in ton miles per month for the engine and schedule being considered. Thus for the first arrangement we have $\frac{720}{41} \times 217.500 = 3,820,000$ ton miles per month of 30 days, and so for the other values on line 20. Further, if we divide the values of line 8 by those of line 4 expressed in hundreds, we obtain the pounds of coal burned per 100 ton miles, as indicated by line 21. From lines 19, 20 and 21 we find that if our engine is loaded so that it can and does make a running speed of 15 miles an hour, with delays approximating 20 per cent. of the running time, or an average speed between terminals of 12½ miles an hour, we will move the greatest volume of traffic, will operate at the lowest rate per ton mile for expenses, and will also consume the least amount of coal per ton mile hauled.

Before drawing our conclusions, however, let us examine some other profiles and find out how the question of load and speed then affects the results. The case which we have just studied was that of a continuous rise of 1 per cent. throughout the 150-mile division; let us now consider a division of the same length, but having a summit in the middle, and a continuous grade of 1 per cent. approaching this summit from both ends of the division. This will amount to an average level, as both ends of the division will of necessity be at the same altitude. We will suppose that a speed of 25 miles an hour is maintained on the down hill portion, and that no fuel is burned while descending. This is not strictly true, as the air pump will require a certain amount of steam, but the variation will no doubt be negligible as between trains of various loading, such as are likely to be assigned to the engine. Table B gives the results of these calculations. As the controlling grade is identical with our first case, line 3, the net weight of train will be the same as before; also the ton miles, as in line 4. The time between terminals is reduced by the higher downhill speed; thus for the first schedule the uphill portion will consume $\frac{75}{5} = 15$ hours, and the downhill portion $\frac{75}{25} = 3$ hours, and allowing 20 per cent. for delays we have $(15 + 3) \times 1.20 = 21.6$ hours. The other values are obtained in the same manner, as per line 5. The average speed between terminals (line 6) is simply 150 divided by the time occupied.

While the amount of fuel consumed per mile going up hill is the same as before, as seen by line 7, the amount for the trip will be only one-half as much, as the last half of the run is made without using coal, according to our hypothesis, and as seen by line 8. Line 9 is the cost of such fuel and lines 10 to 13 inclusive are identical with the previous case, as the train miles and ton miles are identical. The wages of the engine and train crews will be different in the first schedule, but as all the others exceed 10 miles an hour, they will be the same as the last schedules of Table A. These are found in lines 14 and 15. The roundhouse labor, line 16, is identical with the previous case. The interest charges (line 17) are at 10 cents an hour, the time being 5 hours greater than the time between terminals. Lines 18 to 21 show the cost per trip, per 1,000 ton miles, coal per 100 ton miles and the rate of monthly movement as before. In this case we see that for an up hill speed of 15 miles an hour we again obtain the minimum rate of coal consumption and the maximum amount of ton mileage made per month; also the lowest cost per ton mile of train handled. The latter will run about 75 per cent. of the cost figured for the first case, where the grade was a continual rise throughout the division, but it must be remembered that we did not figure on any down hill work, as the balance of traffic was considered to be in the direction of the up grade. Besides, we are discussing the relative economy more than the actual cost of operation.

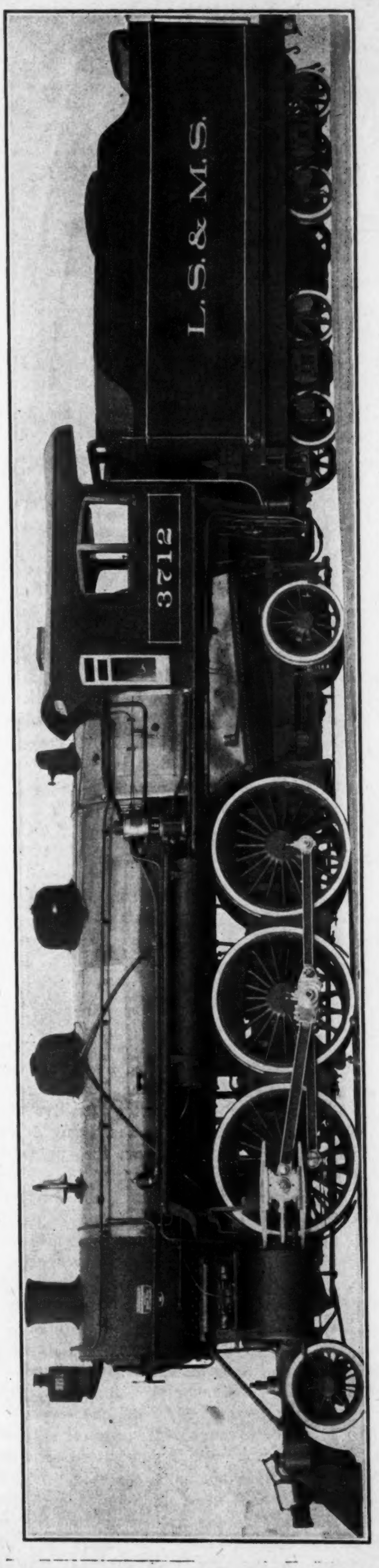
(To be continued.)

TABLE A.

1.	Running speed, miles per hour	5	10	15	20	25
2.	Weight of train, gross, tons of 2,000 lbs	1,600	1,570	1,240	960	750
3.	Weight of train, net, tons of 2,000 lbs	1,450	1,420	1,190	810	600
4.	Ton miles per trip, back of tender	217,500	213,000	178,500	121,500	90,000
5.	Time between terminals, including lay-outs	36 hrs.	18 hrs.	12 hrs.	9 hrs.	7.2 hrs.
6.	Average speed between terminals, miles per hour	4.2	8.3	12.5	16.7	20.8
7.	Coal burned, lbs. per mile	700	800	530	400	300
8.	Coal burned per trip, lbs	105,000	120,000	79,500	60,000	45.000
9.	Cost of coal per trip, at $2 a ton	$105.00	$120.00	$79.50	$60.00	$45.00
10.	Locomotive supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
11.	Train supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
12.	Repairs to Locomotives at 8 cents per 1,000 ton miles	17.40	17.00	14.30	9.73	7.20
13.	Repairs to cars at 15 cents per 1,000 ton miles	32.60	31.90	26.80	18.22	13.50
14.	Pay of enginemen, per schedule	25.20	12.60	10.50	10.50	10.50
15.	Pay of trainmen, per schedule	28.98	14.49	12.08	12.08	12.08
16.	Roundhouse labor, at $2 a trip	2.00	2.00	2.00	2.00	2.00
17.	Interest on locomotive and caboose at 10 cents per hour	4.10	2.30	1.70	1.40	1.22
18.	Total cost of trip, charges 9 to 17	$219.78	$204.79	$151.38	$118.43	$96.00
19.	Cost per 1,000 ton miles hauled	1.01	.96	.85	.97	1.06
20.	Ton miles hauled per month	3,820,000	6,670,000	7,560,000	6,250,000	5,300,000
21.	Lbs. coal per 100 ton miles	48.2	56.4	44.5	49.5	50.0

TABLE B.

1.	Speed, up hill, miles per hour	5	10	15	20	25
2.	Speed, down hill, miles per hour	25	25	25	25	25
3.	Weight of train, net, tons of 2,000 lbs	1,450	1,420	1,190	810	600
4.	Ton miles per trip, back of tender	217,500	213,000	178,500	121,500	90,000
5.	Time between terminals, including lay-outs	21.6 hrs.	12.6 hrs.	9.6 hrs.	8.1 hrs.	7.2 hrs,
6.	Average speed between terminals, miles per hour	7.0	11.9	15.6	18.5	20.8
7.	Coal burned up hill, lbs. per hour	700	800	530	400	300
8.	Coal burned per trip, lbs	52,500	60,000	39,750	30,000	22,500
9.	Cost of coal per trip, at $2 a ton	$52.50	$60.00	$39.75	$30,00	$22.50
10.	Locomotive supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
11.	Train supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
12.	Repairs to Locomotives, at 8 cents per 1,000 ton miles	17.40	17.00	14.30	9.73	7.20
13.	Repairs to cars at 15 cents per 1,000 ton miles	32.60	31.90	26.80	18.22	13.50
14.	Pay of enginemen, per schedule	15.12	10.50	10.50	10.50	10.50
15.	Pay of trainmen, per schedule	17.40	12.08	12.08	12.08	12.08
16.	Roundhouse labor, at $2 a trip	2.00	2.00	2.00	2.00	2.00
17.	Interest on locomotive and caboose at 10 cents per hour	2.66	1.76	1.46	1.31	1.22
18.	Total cost of trip, charges 9 to 17	$144.18	$139.74	$111.39	$88.34	$73.50
19.	Cost per 1,000 ton miles hauled	.66	.66	.62	.73	.82
20.	Ton miles hauled per month	5,880,000	8,700,000	8,800,000	6,680,000	5,300,000
21.	Lbs. coal per 100 ton miles	24.1	28.2	22.3	24.7	25.0



SIX-COUPLED PASSENGER LOCOMOTIVE 2—6—2 (PRAIRIE) TYPE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

THE HEAVIEST PASSENGER LOCOMOTIVE.

H. F. BALL, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY (BROOKS WORKS) *Builders.*

POWERFUL PRAIRIE TYPE PASSENGER LOCOMOTIVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Ten magnificent passenger locomotives from the Brooks Works of the American Locomotive Company have just been put into service on the Lake Shore & Michigan Southern Railway. They are the heaviest passenger locomotives ever built, and are specially noteworthy because of their power, their heavy wheel loads and the wheel arrangement, which indicates the satisfactory service on this road of the 2—6—2 type. The perpetuation of this type ably supports the statements made in describing the Burlington engine on page 356 of the September number and the argument of Mr. J. Snowden Bell on page 386 of the October number. The new design is noteworthy also because of the past traditions of this road with respect to light locomotives. In this connection it is interesting to know that to meet the exigencies of present practice it has been necessary for the Lake Shore to provide new locomotive equipment at a very rapid rate. Of its present number of locomotives 54.4 per cent. have been put into service within five years. This is sufficient reason for adhering to well-established practice and for the development of designs which involve nothing experimental. These locomotives have been illustrated in this journal, and they constitute a series of which any railroad may be proud. These designs, both passenger and freight, are a result of co-operation between the officials of the road and the builders to produce powerful, serviceable and, incidentally, handsome locomotives. The new Class K engines are so well-proportioned that they do not appear to be large unless another engine is at hand for comparison.

No effort was made to break records as to size and weight. These locomotives were built to do work which now requires the Class J engines (AMERICAN ENGINEER, March, 1901, page 69) to "double head." For example, train No. 19, the "Lake Shore Limited," between Buffalo and Cleveland, 183 miles, often consists of 2 mail cars, 1 dynamo baggage car, 1 buffet smoker, 1 dining car and 8 Pullman sleepers; making 13 cars and weighing 743 tons back of the tender. The schedule speed is 44 miles per hour, including two stops, the time over the division being 4 hours 10 minutes. Train No. 43 usually has 15 cars, weighing 750 tons, making the same distance in the same time with four stops. These figures are taken from the records. The Class J engines will make the time under the most favorable weather conditions, but they are often double-headed. To avoid this the new Class K was brought out.

Comparisons with other typical examples of recent powerful passenger locomotives may be made by aid of the accompanying table:

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

Road.	Engine Number.	Total Weight.	Total Heating Surface.	Total Weight Divided by Heating Surface.
L. S. & M. S.	3,712	233,000	3,905	59.6
C. & A.	601	219,000	4,078	53.7
N. Y. C.	2,794	218,000	3,757	58.2
El Paso & S. West'n	——	209,500	3,818	54.8
C. B. & Q.	1,918	208,070	3,575	58.2
Northern Pacific	284	202,000	3,462	58.3
A. T. & S. F.	1,000	190,000	3,738	50.1
C. & O.	147	187,000	3,533	52.9
L. S. & M. S.	650	174,500	3,343	52.2

RATIOS "LAKE SHORE" 2—6—2 TYPE LOCOMOTIVE.

Heating surface to cylinder volume	312.6
Tractive weight to heating surface	45.1
Tractive weight to tractive effort	5.96
Tractive effort × diameter of drivers to heating surface	598
Heating surface to tractive effort	.132
Total weight to heating surface	63.34
Heating surface to grate area	66.87
Tractive effort to heating surface	7.57

From the photograph the attractive appearance of the new locomotive is seen. These engines have piston valves with inside admission, the Player radial trailing truck, cast-steel frames 6 ins. wide, a new design of pony truck, and the front end is arranged in accordance with the AMERICAN ENGINEER tests of locomotive draft appliances. It is impracticable to present this interesting design in a single article. The draw-

ings and information concerning a number of important details must be reserved until next month.

PRAIRIE TYPE PASSENGER LOCOMOTIVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Fuel	bituminous coal
Weight in working order	233,000 lbs.
Weight on drivers	166,000 lbs.
Wheel base, driving	14 ft. 0 ins.
Wheel base, total	34 ft. 3 ins.
Wheel base, total engine and tender	62 ft. 4½ ins.
Tractive power	27,850 lbs.

CYLINDERS.

Diameter of cylinders	21½ ins.
Stroke of piston	28 ins.
Diameter of piston rod	4 ins.
Kind of piston packing	Dunbar

VALVES.

Kind	piston, 12 ins. diameter
Greatest travel	5½ ins.
Outside lap	1¼ ins.
Inside clearance	⅛ in.
Lead in full gear	1-16 in.

WHEELS, ETC.

Number of driving wheels	6
Diameter of driving wheels outside of tire	79 ins.
Material of driving wheel, centers	72 ins.
Thickness of tire	3½ ins.
Diameter of trailing wheels, outside tire	48 ins.
Diameter and length of driving journals	9½ ins. x 12 ins.
Diameter and length of trailing journals	8 ins. x 14 ins.
Diameter and length of main crank pin journals	7 ins. x 6½ ins.
Diameter and length of side rod journals	7½ ins. x 4¾ ins.
Diameter and length of F journals	5 ins. x 4 ins.
Diameter and length of B journals	5 ins. x 4½ ins.
Engine truck, kind	two wheeled swing center
Engine truck; journals	6½ ins x 12 ins.
Diameter of engine truck wheels	42½ ins.

BOILER.

Style	extended wagon top, radial stay
Outside diameter of first ring	70 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox,	11-16 in. ¾ in. 25-32 in. 9-16 in., 9-16 in. 9-16 in.
Fire box, length	109 ins.
Fire box, width	74 ins.
Fire box, depth	front, 80½ ins., back, 68 ins.
Fire box plates, thickness, sides,	⅜ in., back, ⅜ in., crown ⅜ in., tube sheet ½ in.
Fire box, water space	4½ ins., front 4½ ins., sides, 4 ins. back
Tubes, number	322
Tubes, spacing	¾ in. front, 13-16 in. back.
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	19 ft. 6 ins.
Fire brick, supported on	4—3 ins. tubes
Heating surface, tubes	3,678 sq. ins.
Heating surface, water tubes	29 sq. ft.
Heating surface, fire box	198 sq. ft.
Heating surface, total	3,905 sq. ft.
Grate surface	55 sq. ft.
Grate, style	rocking
Ash pan, style	Hopper
Exhaust pipes	single
Exhaust nozzles	5½ ins. and 5¾ ins, diameter
Smoke stack, inside diameter	18 ins. and 21¾ ins.
Smoke stack, top above rail	14 ft. 10½ ins.
Cab material	steel

TENDER.

Style	water bottom, gravity slides
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	18 ft. 0 ins.
Tender frame	13-in. channels.
Tender trucks	arch bar, cast steel bolster
Water capacity	7,800 U. S. gallons
Coal capacity	15 tons

NEW POWERHOUSE—WEST ALBANY SHOPS.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

In this journal in February, March, April and May of the current volume a thorough, illustrated description of the power station at the Weehawken terminal was presented. That station represented modern practice as embodied in all features which would contribute to economy, and is therefore an excellent example of up-to-date engineering. The plant at the West Albany shops furnishes power for lighting and driving the shops. The plans provide for elevated coal storage, also for coal and ash handling facilities; but these are not to be installed at present. As the exhaust steam will be needed for shop heating, condensers were not included. The plant is of good, substantial construction, and admirably suited to the purpose. It supplies alternating current for shop motors and lighting, and direct current for the crane motors. For this reason the plant is of special interest at this time. These shops are not new, but are being rearranged and rebuilt. The powerhouse is part of a plan for modernizing the method of driving whereby motors will entirely replace belt transmission from an old engine plant.

In its generic features the powerhouse resembles that of the Weehawken terminal. It has a central stack with boilers on each side, and the arrangement used in that station was modified to meet the conditions of a shop plant.

Building.—The structure is of brick, with stone trimmings. It is substantial, but plain. The outside dimensions are 113 ft. 4 ins. by 92 ft. 8 ins., with an engine room 110 ft. 4 ins. by 46 ft., inside, and a boiler room 110 ft. 4 ins. by 42 ft., inside. The engine room has a clear height of 28 ft. under the roof trusses, giving plenty of headroom. There is no crane in the engine room, but the pilasters provide for the construction of runways to be built later if needed. The ash tunnel is 10 ft. deep by 14 ft. wide; it and the ash hoppers are waterproofed with 5-ply felt and asphalt. A small vertical ash hoist in the corner of the building raises ashes to an overhead bin, which discharges into a car standing on the coal trestle. This may later be replaced by coal and ash handling apparatus. At present coal is delivered by cars on a trestle over a bin holding 125 tons, which brings the coal to the fireroom floor through the wall. The stack, machinery, boiler and building foundations are of concrete. The roof is of reinforced concrete slabs, 3 ins. thick, over steel roof trusses. It is covered with pitch and slag roofing. All floors are of concrete. Terra cotta segmental blocks are used for the main floor of the engine room and the floor over the ash tunnel.

Boilers.—Four 500 h.p. water-tube boilers were supplied, in 2 batteries of 2 boilers each, by the Franklin Boiler Works Company. The boilers work under 200 lbs. pressure, and they provide 10 sq. ft. of heating surface per horse-power. An evaporation of 9 lbs. of water from and at 212 degs. per pound of run-of-mine Clearfield coal of 12,000 B. T. U. is guaranteed. Each boiler is supported by stub posts of steel, those at the boiler fronts being constructed so as to permit of upward extension to support an overhead coal storage bin at some future time. The boiler supports are entirely independent of the brickwork, allowing expansion and contraction to take place without effecting the setting.

Chimney.—The chimney is of radial brick, 165 ft. high, with an internal diameter of 10 ft., and was built by M. W. Kellogg & Company. At the base of the stack a baffle wall 36 ft. high is built across the core to prevent interference of the gases from the two breeching connections.

Height of chimney above foundations	165 ft. 6 ins.
Height above boiler room floor	165 ft. 0 in.
Height of base above foundations	36 ft. 6 ins.
Side of base at top (outside)	17 ft. 3 ins.
Side of base at bottom (outside)	17 ft. 3 ins.
Diameter of base at top (inside)	11 ft. 5 ins.
Diameter of base at bottom (inside)	11 ft. 5 ins.
Height of round shell	129 ft. 0 in.
Weight per foot of radial brick section	128 lbs.

Piping.—In the absence of economizers and superheaters the piping is simpler than that at Weehawken. The engravings clearly illustrate the headers and connections for live and exhaust steam. The main steam header is short, and drains to the drop legs. Separators are located oven the engine throttles. Steam for the auxiliaries is carried in a header under the engine room floor, and is piped to the low-pressure cylinders of the engines for use in emergencies. This auxiliary header has two connections to the main high-pressure header in the boiler room. This header connects with the heating system through two reducing valves, reducing the pressure from 175 lbs. to 1 lb. per square inch for the heating main at the south end of the building, and to 10 lbs. at the north end. The exhaust piping is clearly shown in the engravings. It leads to a large exhaust tank in the basement of the engine room. The main steam header is anchored near the center, and is supported on carriers with rollers.

The boiler feed piping is arranged in duplicate. There are two duplex boiler feed pumps, with a guaranteed capacity of 22,000 gals. of water per hour against a working pressure of 300 lbs. The Holley system is used, as installed by Westinghouse, Church, Kerr & Co., for returning the high-pressure drips to boilers automatically. The main and auxiliary exhaust piping is specially well drained. The feed pumps take steam from the end of the high-pressure

header in the boiler room. A large blow-off tank receives the water from the blow-off piping, as shown in the drawings of the boiler room. The feed-water heater is located beside the exhaust pipe in the boiler room, above the feed pumps. It is a Cochrane open heater of 1,600 h.p. capacity.

Main Engines.—Two horizontal cross-compound direct-connected Ball & Wood engines constitute the power units. They slight adjustment of speed may be effected while running, thus facilitating the synchronizing of the generators or changing the load carried by the engines. The following are the principal dimensions of the engines:

High-pressure cylinders, diameter	21 ins.
Low-pressure cylinders, diameter	41 ins.
Stroke	30 ins.
Normal full load speed	120 r.p.m.
Normal indicated horse-power	900

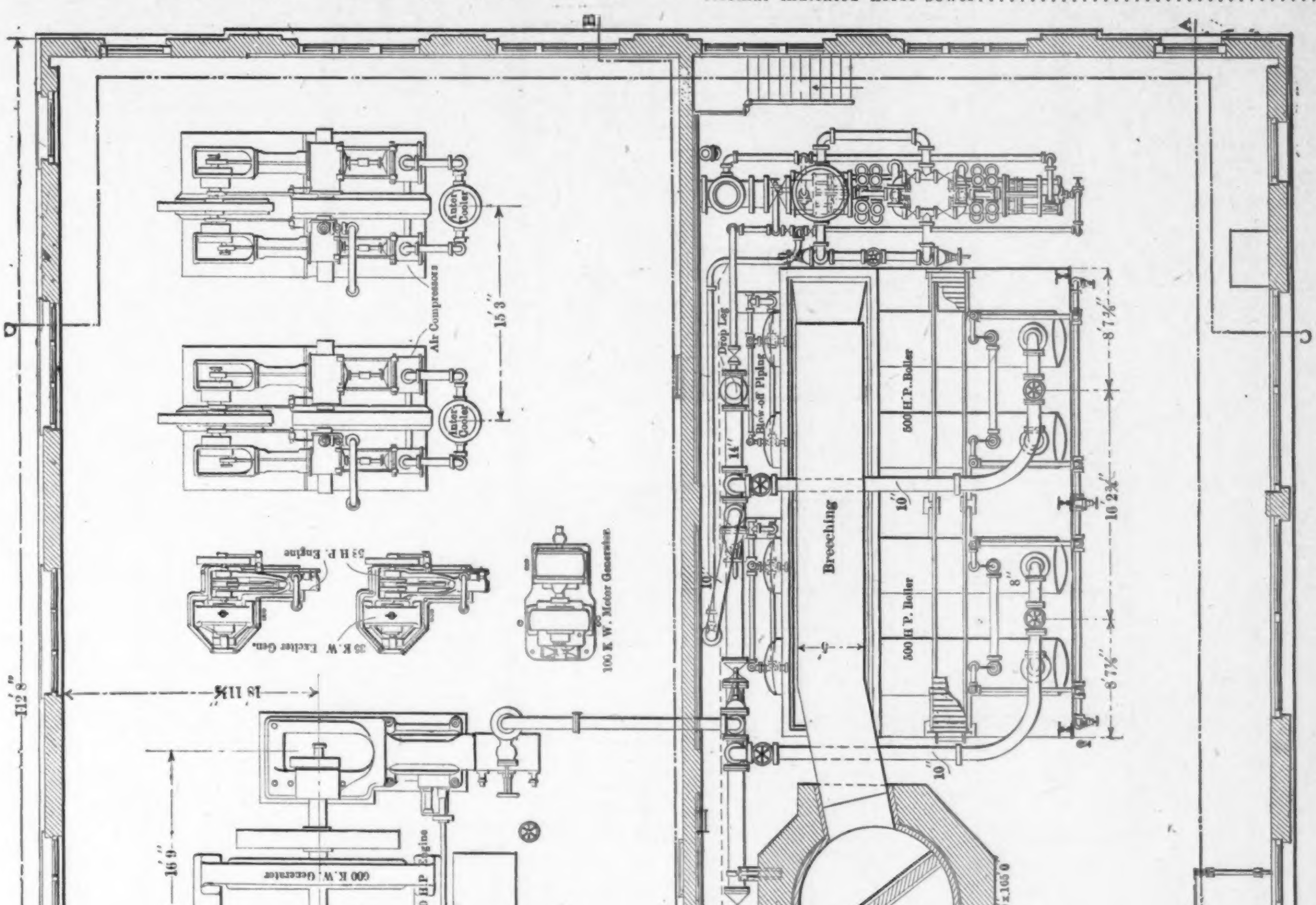


FIG. 1—PLAN OF MAIN OPERATING FLOOR OF BOILER AND ENGINE ROOMS.
WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.

are required to govern so that the speed during one revolution shall not vary as much as to allow the generator, while delivering from no load to full load, to advance ahead or fall behind a machine running at absolutely constant speed by more than 0.08 of 1 deg. The speed of each engine is controlled from the station switchboard by a speed-changing device whereby a

Normal cut-off, high-pressure cylinders, about	37 per cent.
Normal cut-off, low-pressure cylinders, about	37 per cent.
Maximum cut-off, high pressure cylinders, about	65 per cent.
Diameter of fly-wheel	144 ins.
Weight of fly-wheel	40,000 lbs.
Governors	inertia shaft type

Exciter Engines.—For the two 35 kw. exciter units, simple 7-in. by 12-in. Woodbury engines are used. These are required

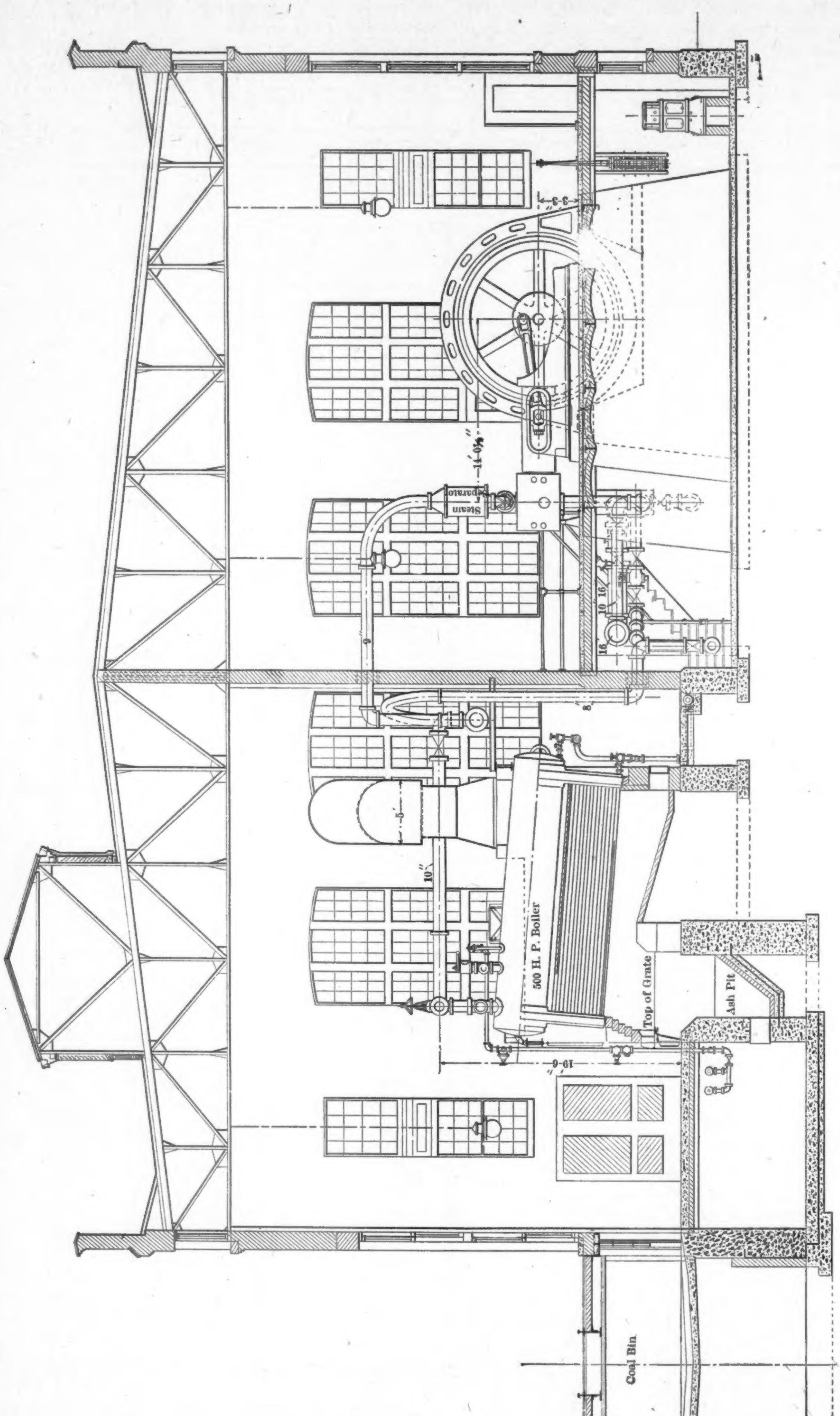
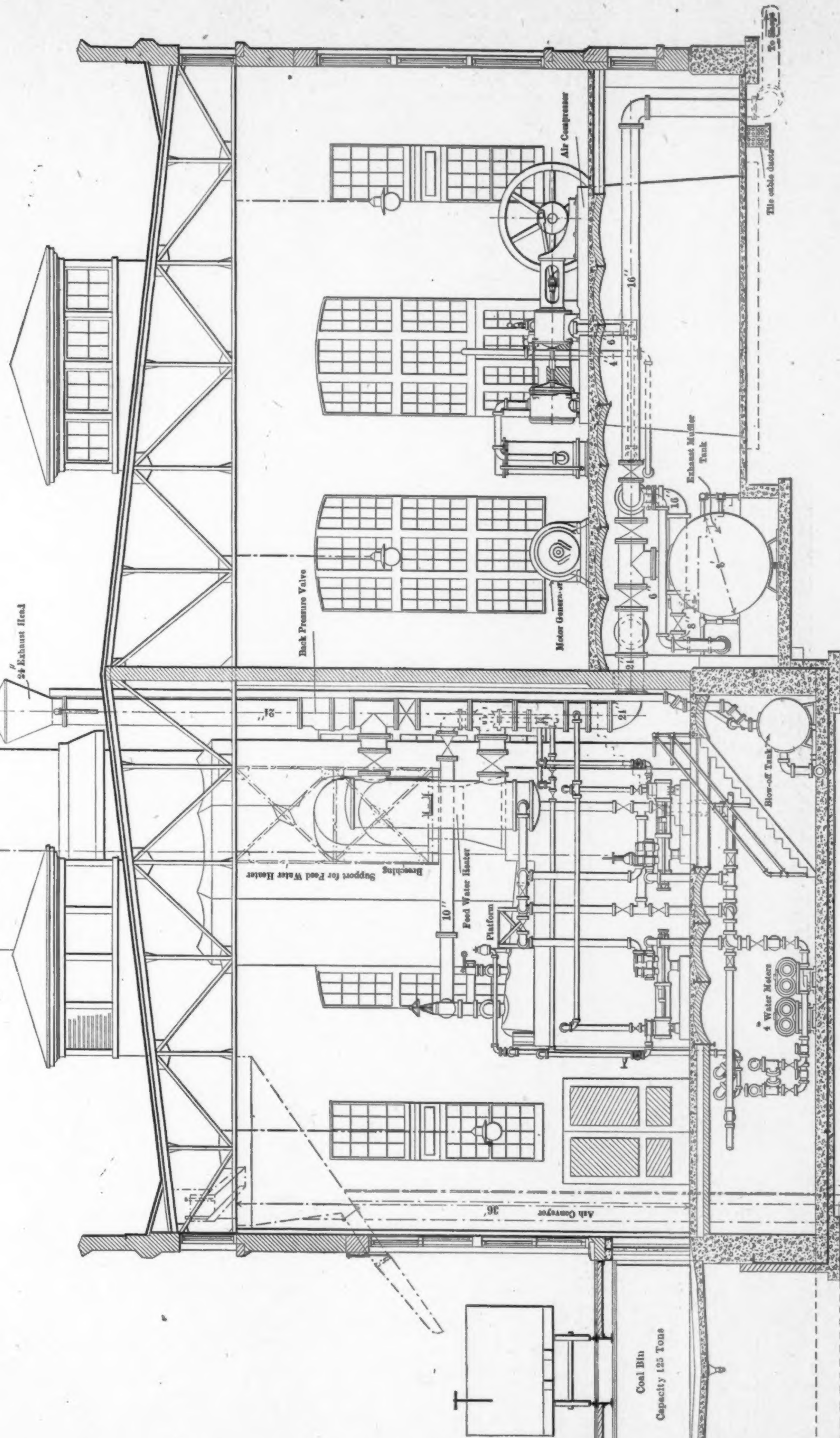


FIG. 2—SECTION THROUGH BOILERS AND MAIN ENGINES.

WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.



Cross Section through CC

FIG. 3—SECTION THROUGH BOILER AND ENGINE ROOM SHOWING AIR COMPRESSORS AND EXHAUST AND BOILER FEED PIPING.

WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.

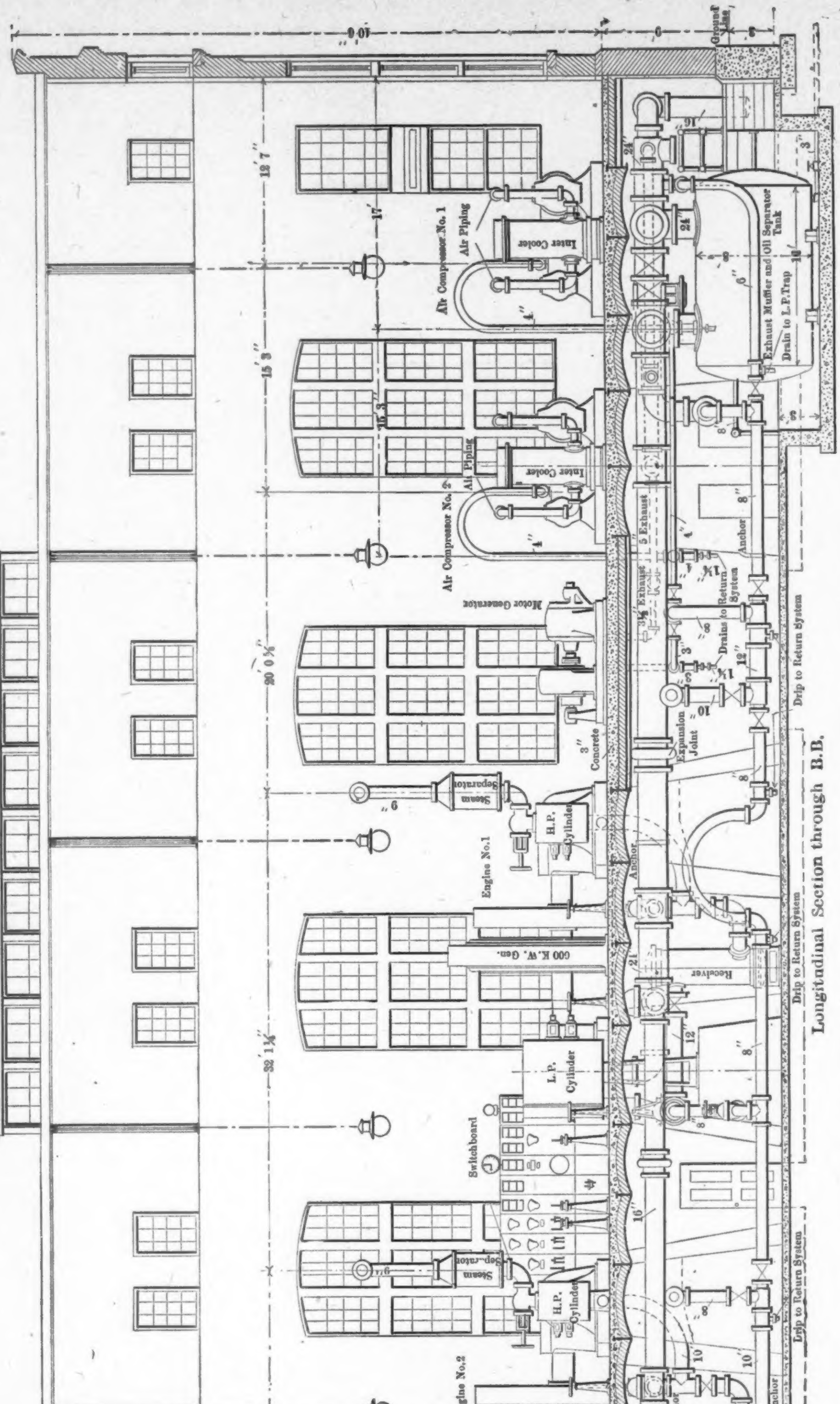


FIG. 4—LONGITUDINAL SECTION THROUGH ENGINE ROOM SHOWING STEAM PIPING.

WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.

to run in parallel with a speed variation of 2 per cent. from full load to no load, and speed-changing devices are applied which permit of adjusting the speed within 7 per cent. of the normal rated speed. The principal dimensions are as follows:

Diameter of cylinders	7 in.
Stroke	12 in.
Normal full load speed	300 r.p.m.
Normal indicated h.p.	58
Normal cut-off	20 per cent.
Maximum cut-off	50 per cent.

revolving field type, located between the cranks of the engines, and are run in parallel, having the same armature impedance in both machines. The normal rating of each machine is 722 amperes per terminal at 480 volts and 100 per cent. power factor. The normal rated output is therefore 600 kw. The collector rings on each generator are ample to carry an excitation current for 150 per cent. of the normal rated load, with a power factor of 80 per cent. The increase of pressure when the non-

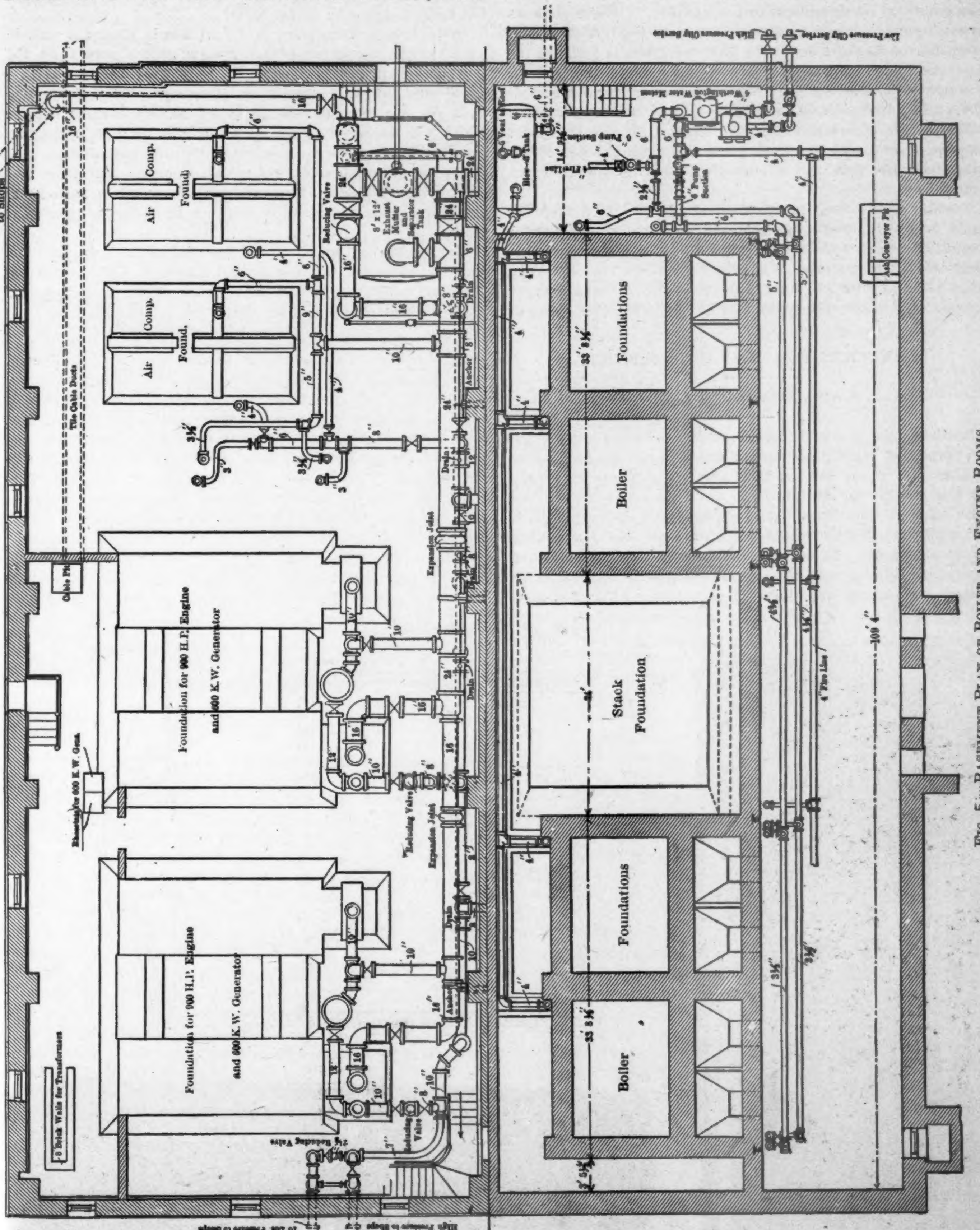


FIG. 5.—BASEMENT PLAN OF BOILER AND ENGINE ROOMS.
WEST ALBANY POWER PLANT—NEW YORK CENTRAL RAILROAD.

Generators.—Two, engine type, 600 kw. alternating-current General Electric generators supply 3-phase current at 60 cycles per second at 480 volts, for light and power. They are of the inductive load is varied from no load to full load, without change of excitation, is required to be limited to 5 per cent. The generators are proportioned so that with a power factor of

100 per cent. the load may be varied from 0 to 150 per cent. of the rated load without varying the voltage more than 12 per cent. and without change of excitation. They are proportioned for 100 per cent. momentary overloads.

Exciter Generators.—These are 35 kw. direct-current General Electric machines, and each is of sufficient capacity to supply the entire current, which varies from 45 amperes at 170 volts to 140 amperes at 250 volts. Ninety amperes at 170 volts is also required. They are operated in parallel. These generators have shunt resistance across the series field, adjusted for an overcompounding of 2 per cent. The series field is designed for 5 per cent. overcompounding without shunt resistance.

Motor Generator Set. — As the main power circuits are all alternating, direct current is supplied for the cranes by a motor generator set, also supplied by the General Electric Company. The set consists of a 60-cycle 3-phase alternating motor of 900 r.p.m. and 480 volts and a multipolar 250-volt direct-current generator.

Transformers.—The transformers are located in a fireproof vault, with 8-in. brick walls, in the basement of the engine room. There are three 200-kw. 60-cycle 480 to 2,300 volt transformers. These are capable of carrying 200 kw. for one hour when supplied with air through ducts of 2 sq. ft. area without the use of the blower set; the rise of temperature is required not to exceed 55 degs. Cent. under these conditions. The blower set has a capacity of 2,700 cu. ft. of free air per minute, delivered at a pressure of 0.75 oz. It is driven by a 480-volt 60-cycle 3-phase 1 h.p. induction motor. The air ducts are arranged to be used with natural as well as artificial draft.

The transformers are for the lighting circuits and the motor driving the coal storage plant, this being 3,500 ft. from the powerhouse. All the other circuits are of 480 volts for power, the motors operating at 440 volts.

Switchboard.—This plant is up to date in having a switchboard house, which removes the main switchboard from the powerhouse, rendering it necessary to provide merely a station board near the main generators. This switchboard house was built for use in connection with an outside current supply, which was depended on for such shop motors and lighting as were installed before the erection of the new powerhouse.

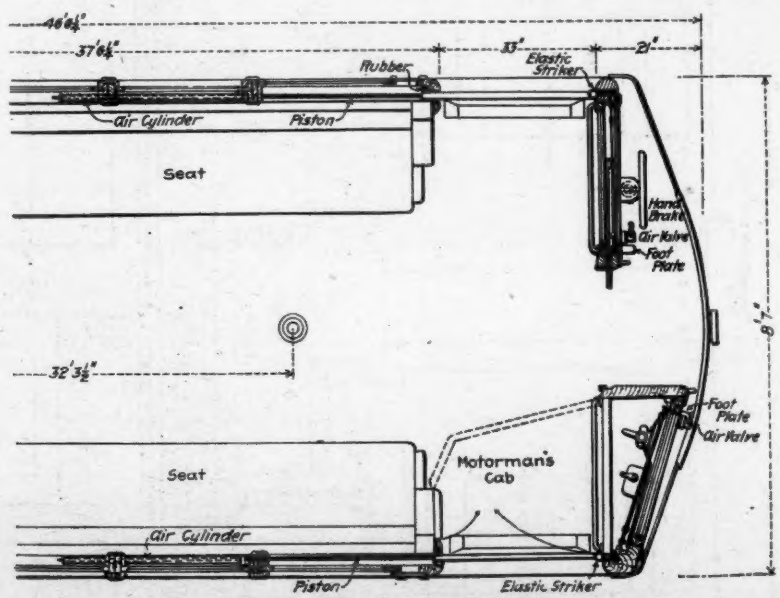
The two air compressors are cross-compounds, with 16-in. and 27-in. steam cylinders, 24-in. and 14-in. air cylinders, with 18-in. stroke and with a capacity of 1,225 cu. ft. of free air per minute each.

The mechanical and electrical features of the power station were designed and executed by Mr. Edwin B. Katte, electrical engineer, under the general supervision of Mr. H. Fernstrom, chief engineer of the company.

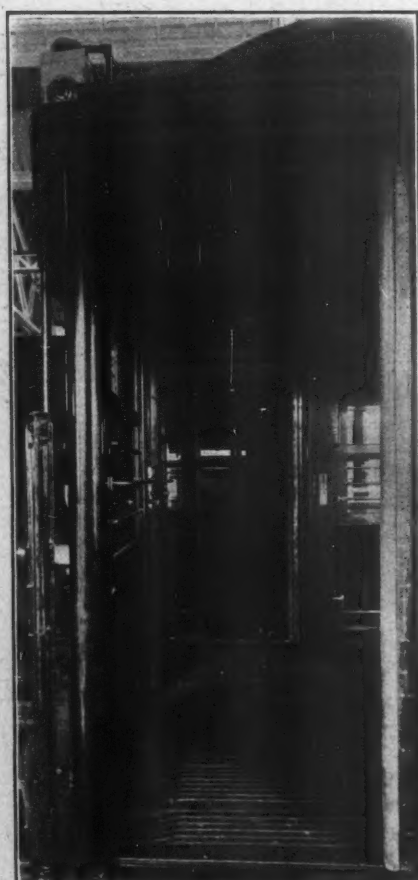
NEW CARS FOR ELEVATED SERVICE.

Boston Elevated Railroad.

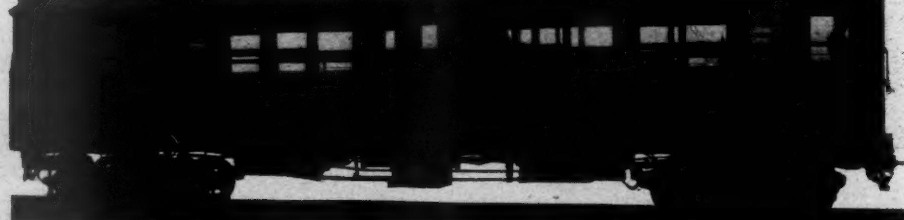
Realizing the necessity for improving car construction for the purpose of rapidly loading and unloading passengers, a new arrangement of car end has been adopted in 24 new cars built for this road by the St. Louis Car Company. The earlier cars were all built like those in use on the Brooklyn Bridge, with end platforms (partly vestibuled by the cab doors) and wide centre side doors. These centre doors are used for egress of passengers during rush hours, the end doors being used at such times for entrance only. This requires additional platform attendants to open the side doors from the outside at every station. Crowds entering the end doors find an obstruction at the constricted entrance, and there is great difficulty, as on the Manhattan Elevated, in closing the swinging platform gates against the pressure of the crowds on the platforms. In the new cars the platforms form part of the car itself, and are not separated from the body by either doors or partitions. The vestibules form the ends of the car. Pneumatically-operated sliding doors take the place of the swinging iron gates, and these slide into the car siding, where they are entirely out of the way. The center side doors are retained, they are 40 ins. wide and are used as before. Sliding doors are provided at the ends of the vestibules, but these are narrow, being for the



Plan of End of New Cars.



Looking Across Vestibule.



New Car for the Boston Elevated.

use of the trainmen only. To form the motorman's cab two doors are arranged to enclose a corner of the vestibule. One of these swings against the vestibule, protecting the controller and air brake devices and the other, which is narrower, swings against the end of the adjacent seat. To open the sliding doors the trainmen step on a lever, which releases a lock, and then by means of another lever, air is applied to a cylinder in the upper framing, the piston rod of which operates the door. To avoid shock and to permit of releasing clothing which may be caught in the door a rubber cushion is provided, which closes the door opening.

The side doors are used as exits from 6.30 to 10.30 a. m. every day and from 3 to 8 p. m., except on Saturdays and Sundays. They are used from 12 noon to 11.30 p. m. on Saturdays and from noon to 10.30 p. m. on Sundays. One of the engravings shows the sign at the center of the car giving information as to the exits which the passengers are to use.

The average length of main line stops with the present equipment during the rush hours is 20 and 21 seconds, ranging from 13 to 30 seconds. Owing to the fact that the more important stations are used for both elevated and surface traffic no separate record is ordinarily kept of the elevated passengers. On

INTERIOR OF CAR SHOWING END AND DOORS AT SIDES.

several occasions counts have been made on days that were believed to represent normal conditions and not exceptionally heavy riding. The largest number leaving elevated trains in any one hour was 8,557, one day last spring, at the Sullivan Square Station between 5 and 6 p. m. The largest number leaving any of the stations in an hour was 7,333 on the same day at Sullivan Square, between 7 and 8 a. m. These crowds were handled in four-car trains at the rate of thirty trains per hour. These interesting figures show the size of the problem and the importance of ready ingress and egress to and from the cars.

If any improvement may be made whereby 10 seconds may be saved in the average delay at each station the total saving in time would permit of running one additional train on the line. The possibilities of improvement through the use of these new cars has not been estimated, but they are expected to help materially in accelerating the service.

RAILROAD ACCIDENTS.—According to the statistics of the Interstate Commerce Commission for the year ending June 30, 1904, there were 55,130 casualties, 3,787 persons killed and 51,343 injured on the railroads of the United States. This is an increase of 5,599 casualties over the previous year, or 233 killed and 5,366 injured. These figures do not include highway crossings accidents or those to trespassers or persons walking along the tracks, in shops remote from the railroad or to employes not actually on duty.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

LONDON, ENGLAND.

MIDLAND SHOPS AT DERBY.

It might be unfair if I said that the Derby shops are the most interesting in England. I shall say, however, that of the shops which I visited these impressed me most as indicating the possibilities of improvement and development of a very old plant. This road will get the utmost from its present facilities and then will be ready to invest in a new plant. After visiting Derby, many opinions with respect to shop practice formed in England required modification, and if I find another shop which interests me more I shall give it high praise. It was my good fortune to be conducted by Mr. Cecil Paget, works manager, whom many of the readers of this journal have met in the United States. The Midland has a total mileage of 2,300 and is second in England in this respect. It is marvelously compact, with a trunk line about 310 miles long from London to Carlisle. Its train mileage amounts to about 45,000,000 per year, its locomotives number 2,900 and the repairs center at Derby. The plant occupies about 80 acres. Those desiring to make a comparison between these shops and ours may find the following figures of interest:

DERBY SHOPS.

	Area Sq. Ft.
Machine and fitting shops	54,000
Smith shop No. 19	21,600
Smith shop No. 20	4,600
Erecting shop	67,500
Wheel turning shop	9,813
Wheel press shop	15,214
Axle shop	10,867
Tire and plate shop	24,656
Boiler shop (3 buildings)	84,949
Pits in erecting shop	50
Pits for examination	12
Spaces for boilers under repairs	10
Average output of erecting shop in locomotives per week undergoing heavy repairs	23

I greatly regret the necessity for hurrying through these interesting shops. This plant may be quite thoroughly gone over without going out of doors but once. This is an important matter in a shop with a capacity of 100 locomotives per month for heavy repairs. The buildings are exceedingly well lighted and if they were sufficiently high for good crane service they would be satisfactory for many years more. This is an excellent example of an old plant which is being systematically but gradually modernized. The plan is to make the most out of existing facilities before undertaking expensive new ones. In the development the most vitally important factors are being considered first and the improvements seem to be very thoroughly planned. Without any extensive changes in the organization, the individual output of the workmen has been practically revolutionized by liberal and broad-minded administration of piecework. It is generally believed that English workmen cannot be hurried, but certainly the pace in these shops is fast enough to put many of our own shops to shame. In these shops there are plenty of blue chips under the machines and improved tool steels are being introduced rapidly. The cutting speeds are not high, but this will come gradually. By a combination of improvements applied during the past three or four years the present erecting shop has doubled its output and now does 30 per cent. more work than was formerly done in two erecting shops. Much of this is due to piecework treatment, under which the men have in some cases quite doubled their day rates. It is a pleasure to come into contact with such an effort as this. It is not by any means complete, but Derby will soon be a place for American motive power men to visit with special profit.

Piece rates are never changed here unless justified by a change in machinery or method. Then they are sometimes changed radically. Jigs and templates are extensively used. The standardization of the locomotives and the interchangeability of parts plays an important part in this, and one would expect to find many jigs used on a road having a large number of locomotives of comparatively few individual types.

An excellent example of jig work was noticed in connection with the bolt holes for frames and cylinders. The frames and

cylinders for the largest passenger engines are all drilled before the parts go to the erecting shop and when put together the holes are not even reamed. The writer saw this work himself and with surprise. This sort of thing has reduced the cost of erection of new locomotives within a short time in the ratio of 30 to 12. At Derby very little hand fitting is done. Links and motion work connections are lapped to perfect fitting by machinery. While milling is not as extensive here as at Crewe, much of the rodwork is done in this way. I saw eccentric straps milled out on a circular milling machine in piles of three, this process having reduced the cost of the job to one-seventh that of boring on the lathe. For this work built-up cutters are used. Fluted side rods are finished complete on each side by special cutters which face the rod and cut the channels in the same operation. In this shop no milling in two cuts was seen. There were no roughing cuts on the milling machines; but finished cuts only. This is because the works manager does not believe milling to be profitable when a roughing and a finishing cut are taken.

Here was seen the nearest approach to an American tool room with special men grinding tools on a piecework schedule and with annunciators and boys to serve the men at the machines.

This erecting shop is the only one the writer has seen over here having "catacombs" under it. Most effective use is made of large rooms excavated below the erecting shop floor where the small parts of engines are stored after being repaired and while waiting to be wanted by the erecting gangs. An enormous amount of shelving and wall space is thus provided, situated near the engines and admirably arranged and used. Every part may be quickly located by a record book which is indexed. Brake fittings, whistles, valves, cocks and all small parts are stored here and nothing of the sort is to be seen in spaces which could possibly be used for anything else. The gangways in English shops are always too narrow, but this besement helps in a remarkable way at Derby.

These notes are also written in a first class "carriage" on a first class road—the road will not be named because of the pass kindly given by the general manager. It is both rough and rocky and there is no difficulty in counting the rail joints. Mr. Vreeland, of New York, in remarking on the high speeds on foreign roads, told of going 80 miles an hour; 40 miles per hour straight away, 20 miles in vertical and 20 miles in lateral vibration. This must be the road which he referred to (it is not the Midland) and I must revise a previous statement that English track is uniformly good. It is not.

Returning to Derby shop matters, the staybolt fitting is very carefully done. The stays are apparently of nearly pure copper. They are carefully threaded on automatic machines and are most carefully driven in the fireboxes. Here is a good pointer for our own practice, for staybolts are no longer a source of anxiety to the Midland officials. This seems to be due chiefly to careful fitting of the staybolts in the holes in the sheets. The dies and taps are closely watched and carefuly standardized. Bolts varying more than 0.001 in. in diameter from the absolutely correct size are discarded by a simple test which was new to me. The staybolts are rolled down a little flight of four steps, the treads of which are in form of two rollers. The rollers of the top step are set far enough apart to allow a staybolt 0.001 in. over-size to drop through to the second step. If it is more than 0.001 in. too large it will not go through and is rejected. If it is of the exact size desired it will pass through the second step and if 0.001 in. smaller than this it will pass through the third step. A fourth step is made 0.002 in. smaller than the standard and if a bolt passes these rollers it is rejected. This little affair provides a very satisfactory gauge which has a large capacity of inspection.

It would require more than a few hours to see these works properly. I happened to spend the noon hour looking about, and Mr. Paget took me into the mess room where perhaps 800 or more of the shop men were enjoying their dinners in comfort. It was an impressive sight. Before I had a look at the appointments furnished by the company for heating coffee, the men began to rap on the tables with their tin cups. Mr. Paget explained that a speech was wanted. I shall always think that he had a twinkle in his eye as he took me in there. After taking a "snap shot" at the enemy, I escaped unhurt. This messroom plan is a fine thing for the company and for the men. It brings them together as a sort of club at noon and is miles ahead of lunching about the corners of the shop. The Grand Trunk has had a messroom at Montreal for about 40 years. Our railroads at home should take a leaf out of this book because a large proportion of our shop men bring their dinners. It would pay to provide them a clean, comfortable place in which to really enjoy their nooning with a chance to smoke and converse afterward.

Like other English roads, the Midland has simplified in the number of locomotive types and I am told that for 2,500 engines two different designs of slide valves suffice—one is longer than the other in order to provide for different size cylinders, but the ports are all the same size. It is the practice of this road to use rather large cylinders, and small valves; in fact we should say that the locomotives are over-cylindered and under-valved. This road aims to keep the piston speeds of locomotives below 1,000 ft. per minute, and vary the diameter of the driving wheels in accordance with the speed. This works out very well because the very high speed trains are usually comparatively light.

This road is quite partial to the piston valve, and specially those of the Smith type with relieving packing rings which do not require the use of relief valves. The piston valves are small, usually 8¾ ins. in diameter, 10 ins. being the largest. The three-cylinder compounds on this road are giving excellent service, and are very highly spoken of.

Three sizes of boilers suffice for nearly all standard modern engines on this road, including the compounds. The boilers are of two types, the Belpaire and the round top. There are two classes of Belpaire and one round top. In the latter type of standard engines such parts as the boxes and valve gear are interchangeable.

The surprising thing all over England is that with engines over-cylindered and under-valved and under-boilered they give such efficient results. This must be due to the handling. The coal is good and water fairly good. The engines on this road have large nozzles, the cylinders are protected and special attention has been given through admirable experimental work to conditions of combustion, the mixing of the gases in the firebox and to preventing the use of large excess of air. In a test between Nottingham and London a mean sample of smokebox gas taken throughout the two hours' trip gave the following:

Carbonic acid	13.74
Nitrogen	83.10
Oxygen	3.16

The mixing of the gases is obtained by the combination of deflector from the firedoor and the firebrick arch. Great care in the adjustment of locomotives is everywhere apparent and we have much to learn in England in the matter of efficient operation of small engines. Feeling that I have not done justice to many good features of English shop practice, I must leave this subject, hoping to be able to make a more exhaustive study some day.

As already stated, most English engines are not hard worked. From these we have little to learn, but those which are hauling trains in competitive express service are doing wonders, in view of their weight and small heating surfaces. This vigorous passenger competition is playing an important part in English railroad practice and is likely to be far reaching in its effects. For example, the east and west coast lines have struggled in the matter of speed. They will soon apply the same tactics in things which go to make trains heavier. In fact, they have already done so, and this has brought the corridor carriages. Competition has led to a large number of fast, direct trains with long runs without intermediate stops, and this cannot fail to seriously hamper freight service. This already constitutes a problem which must worry general managers not a little.

The very large proportion of private cars constitutes another

problem which only an association of the railroads can solve. These private interests must be reckoned with in any attempt to introduce improvements in cars. The Caledonian is getting excellent service with its large capacity steel frame coal cars (illustrated several years ago in this journal), but they are used chiefly for handling coal for the use of the locomotives. Mr. McIntosh is now introducing hopper-bottom cars for this service. The steel frame cars have done so well that they are practically never seen at the shops. The Midland is also using 30-ton steel coal cars of the gondola type.

Because trains in England are light and because of the fact that the "ton mile" is not in the dictionary of English railroad men, it must not be thought that freight service is not improving from the standpoint of cost of service. The following figures from the *Statist* do not show the mileage or the tonnage, but they indicate a marked improvement in three years:

EARNINGS PER FREIGHT TRAIN MILE IN PENCE.

	1900.	1903.
Lancashire & Yorkshire	110.09	127.5
North Eastern	83.45	104.4
London & North Western	82.05	98.7
Midland	65.52	74.4
Great Central	48.62	68.2
Great Eastern	57.67	68.0
Great Western	59.81	67.3
Great Northern	57.89	68.1

In estimating the value of these records it is absolutely necessary to know the mileage and tonnage, and here is where we are a century or two ahead of England. In the matter of knowing the cost in terms of work done English roads are exceedingly deficient.

Practice in Great Britain with respect to rails and rail fastenings is amusing. When the double head rail and cast iron chair were introduced it was supposed that the rails when worn could be turned over in the chairs and a double life of the rail secured. The discovery of the fallacy of this idea did not lead to a change in the shape of the rail. It remains in the double headed form and the chair is retained, with its wooden wedge. It is true that the chair makes an excellent tie plate, but why the expense of this construction should be perpetuated is unaccountable.

I may not write more from England and therefore take this opportunity to express grateful thanks for the uniformly generous courtesies extended by English railway officials whom I found to be without exception gentlemen of the highest type and most hospitable.

Perhaps a word to those visiting English railroad officials for the first time may be helpful. Naturally these gentlemen are very busy. They work under considerable pressure and they take great care of their time. I found it desirable to send letters of introduction in advance asking for an interview, and invariably found a pleasant reception and the officials with desks clear, ready for a talk. They, however, will not allow themselves to be interrupted as Americans do and they are quite right in this. G. M. B.

(*To be continued.*)

MULTIPLE DRILL WITH ARCH BAR FIXTURES.

This drill has six spindles, and for railroad shop use can be furnished with arch bar fixtures, as shown in the photograph, and when thus equipped can give an output of drilled arch bars nearly equal to any standard arch bar drill on the market. On page 266 of the July, 1904, number of this journal is illustrated a standard arch bar drill made by the same company. As many of the railroad shops do not have enough of this class of work to keep a machine steadily employed, Foote, Burt & Company have arranged their No. 5 independent feed multiple drill to take the adjustable arch bar fixtures, and when these are not required they can readily be removed and the machine can be used for any other class of car or locomotive work, such as drilling brake levers, truck frames, steam chest covers, straps, etc., running the six spindles with one operator and thus very materially decreasing the cost of turning out the work.

MULTIPLE DRILL WITH ARCH BAR FIXTURE—FOOTE, BURT & COMPANY.

Two of these machines in the works of a well-known concern, and with ordinary standard twist drills, which on this

class of work require grinding about eight times a day, and with the arch bars handled by hand, are drilling complete about 85 Pennsylvania Railroad standard 100,000-lb. arch bars per day of 10 hours on each machine. With Novo twist drills and an air hoist for handling the arch bars the output could be considerably increased.

Each head is independently adjustable along the rail without loosening bolts or set screws. The minimum distance between the centre of any two heads is 8 ins., and the greatest centre to centre distance of the outside spindles is 97 ins. Each head is operated by a clutch for both the motion and feed, and thus any spindle can be started or stopped without reference to the other spindles. Three changes of positive feed are provided, and an automatic knock-off permits the feed to be thrown out at any predetermined depth. The table is 24 ins. wide, 121½ ins. long, and adjusts vertically on uprights 14 ins. The maximum distance from the nose of the spindle to the top of the table is 26 ins., and from the face of the upright to the centre of the spindle is 12⅛ ins. The drill weighs complete about 12,000 lbs., and is made by Foote, Burt & Company, of Cleveland.

BALL BEARING CENTER PLATES AND SIDE BEARINGS.

That great advantages would result from the use of frictionless center plates and side bearings under freight cars is apparent. The question is, Can such devices be produced at a reasonable cost to stand the severe service they would be subjected to? They would have to be simple, substantial and such that they would require no attention after being placed under the car. A device that meets the above conditions and at the same time can be used with any type of truck or body bolster construction has been experimented with and developed on the Pittsburg & Lake Erie Railroad during the past seven years with remarkable results.

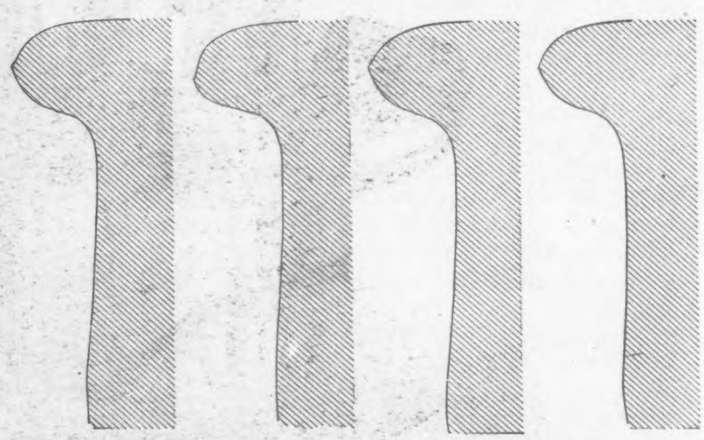
Wheel flange wear on cars equipped with the device has been practically eliminated. The line cut shows the outline of the flange and tread of four wheels of a truck which ran for 81 months under a 60,000-lb. capacity wooden gondola car equipped with the device, making in that time approximately 50,000 miles. The treads are badly worn, but the flanges show very little wear. In passing through the McKees Rocks freight yards of the company the writer recently examined the wheels under 25 steel gondola cars equipped with this device which had been in service 3 years or more and only 2 wheels out of the 200 showed any perceptible signs of flange wear and those two were but slightly worn, considering the time they had been in service.

HARTMAN BALL BEARING CENTER PLATES AND SIDE BEARINGS.

It naturally follows that the wear of the rail flange will be reduced in a like ratio and that less power will be required to haul trains of cars thus equipped. Practical experience and dynamometer tests which have been made from time to time indicate that the train resistance is considerably decreased by the use of these ball bearing center plates and side bearings. A very elaborate dynamometer test was recently made on the Erie Railroad in which representatives from the test departments of the Erie R. R., B. & O. R. R., P. R. R., L. S. & M. S. Ry. and P. & L. E. R. R. participated. The test was made over a distance of 32 miles, but it was decided to base the calculations on a stretch of 10 miles where it was thought the most accurate data were obtained. On this 10 miles there was an average up grade of 0.36 per cent., with only 31 per cent. of straight track. The minimum curve was 45 min., the maximum 4 deg. 45 min. and there were 8 reverse curves. At one point there was a stretch of 3 miles of constant curvature in which there were 4 reverse curves and at another point in a distance of 1 mile of constant curvature there were 3 reverse curves formed by two 4-deg. and two 3-deg. curves. Nine trains, each made up of steel cars of 100,000 lbs. capacity, were tested. Five of the trains, average weight 1,801 tons, consisted of 25 cars each which were equipped with plain center plates and side bearings; 3 trains, average weight 1,733 tons, were made up of 25 cars each which were equipped with ball bearing center plates and side bearings; 1 train of 2,114 tons made up of 30 cars equipped with the ball bearings. The same engine crew and locomotive were used for all the tests. The maximum rating of the locomotive over the division was 1,750 tons. The weather conditions were very uniform; variation in temperature did not exceed 5 deg.

The average train resistance for the flat center plate and side bearing trains was 13.64 lbs. per ton, and for the ball bearing trains 12.14 lbs. per ton—or a decrease of 11 per cent., due to use of ball bearings. Correcting for grade gives a resistance on the level of 6.33 lbs. per ton for the flat center plate and side bearing trains, and 4.93 lbs. per ton for the ball bearing trains, or a decrease of resistance due to use of ball bearings of 22.1 per cent. The water consumption observations confirm these results.

One of the blast furnaces in Pittsburg has a rather steep incline leading to a trestle for unloading ore. Part of the lower end of the incline is on a 25-deg. curve and the level track at the foot of it has a 17-deg. reverse curve and then a long 17-deg. curve. After cars are unloaded they are allowed to drift down the incline, and cars equipped with ball bearings travel on the average more than twice as far as those equipped with plain center plates and side bearings.



OUTLINE OF WHEELS WHICH RUN 81 MONTHS UNDER CAR EQUIPPED WITH BALL BEARINGS.

Other tests of these bearings are described on page 45 of the February, 1902, and pages 263-4 of the August, 1902, issues of this journal.

The construction of the ball bearing center plates and side bearings is shown in the photograph. The balls are 2½ ins. in diameter, made of drop forged steel of .55 carbon. The center plates are of drop forged steel of about .25 carbon. The top

plate has a plain groove 13-16 in. deep, and the bottom plate has six pockets as shown. These pockets are so constructed that as the truck turns the balls travel up a very slight incline, and the truck will thus easily regain its normal position when it strikes a tangent. The ordinary center plates and side bearings offer so much resistance to turning that after the car leaves a curve the wheel flanges will grind on the rail for a considerable distance. The grooves and pockets in the center plates are made so that the balls fit in them snugly and have a good bearing. The side bearings are of malleable iron, and are applied with from ¼ to ⅜ in. clearance on each side. They are equipped with one ball each; the upper one has a plain groove and the lower one a long pocket. As they merely act as balances, they do not carry any great load. The construction of the bearings is such that the balls cannot be thrown out and lost.

No trouble has been experienced with dirt gathering in the bearings and interfering with the action of the balls. The center plates and side bearings under one of the cars were recently packed tight with granulated slag, but it was found that the balls actually forced it out, and that it did not interfere with them. The action of the balls is such that they seem to rotate in all directions, and do not wear out of round.

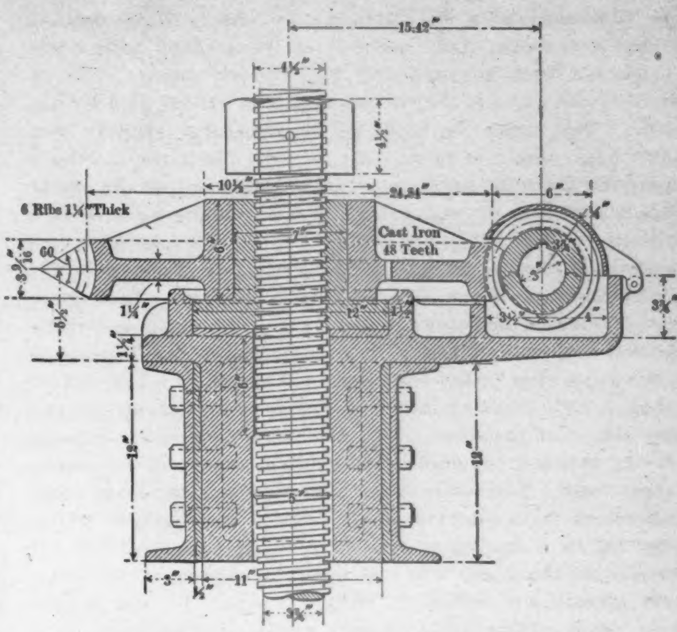
About 7,600 cars are now equipped with these bearings, which are known as the Hartman Ball Bearing Centre Plates and Side Bearings, and which are controlled by the Anti-Friction Bearing Company of Pittsburg.

ELECTRIC LOCOMOTIVE HOIST.

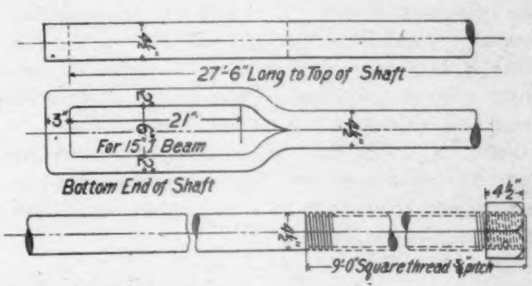
ATCHISON, TOPEKA AND SANTA FE RAILWAY.

While its construction does not involve special originality this hoist is a good example of labor saving machinery which is well adapted for use at shops where for any reason it is not advisable to install powerful traveling cranes.

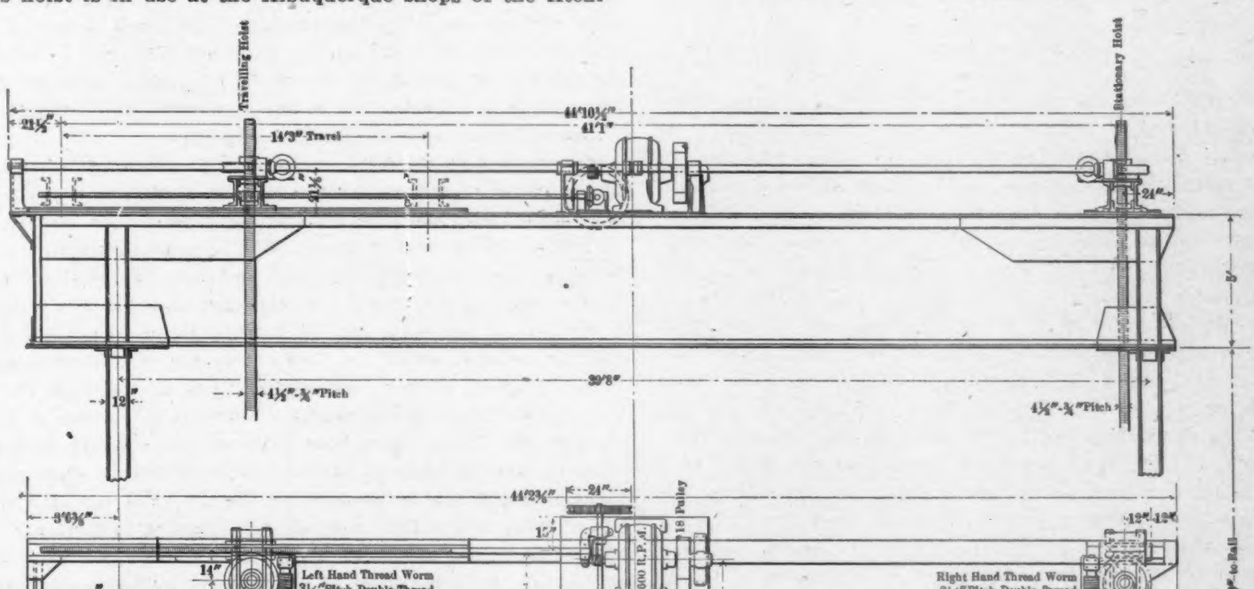
This hoist is in use at the Albuquerque shops of the Atchi-



DETAILS FOR NUT AND SCREW FOR LOCOMOTIVE HOIST.



LOOP HANGER FOR LOCOMOTIVE HOIST.



LOCOMOTIVE HOIST—ATCHISON, TOPEKA & SANTA FE RAILWAY.

son, Topeka & Santa Fe, and a similar one is to be installed at San Bernardino, Cal. Neither of these shops have crane service, but both are equipped with electric power. The capacity of the hoist is 200,000 lbs. and it is driven by a 30 h.p. motor. The frame is built up of structural shapes, with a horizontal length of 39 ft. 8 ins. between the posts, the width across the track being 13 ft. The arrangement of the motor drive is shown in the engraving. One end of the hoist is fixed in position, while the crossrail at the other end may be moved along the structure through a travel of 14 ft. 3 ins. in order to accommodate locomotives of various lengths. This crossrail is traversed by screws driven by a hand wheel and chain reaching down to the floor of the shop. The motor is mounted on the upper part of the frame and, by means of a belt, drives a long shaft extending the full length of the frame on the other side. At the fixed end miter gears drive a cross shaft carrying two worms, meshing with worm wheels at the corner of the hoist. The moveable crossrail also carries a cross shaft driven from the main shaft through a miter gear which is carried on a portion of the shaft which is splined for the traveling of the gear. Thus at the four corners of the hoist worm wheels are driven in either direction by the motor. These worm wheels are also nuts receiving long screw rods by which the locomotives are raised. The lower ends of these rods terminate in forged loops which are made large enough to receive crossbars of 15-in. "I" beams which are passed under the locomotive frames for lifting. Details of the loops and also of the worms and worm wheels, with the thrust collars and lifting screws, are shown. The latter detail also shows the construction of one of the crossrails in section.

The motor is a 30 h.p. variable speed, induction type, controlled by resistance in the revolving winding, and furnished, as was all of the electrical machinery of this plant, by the General Electric Company.

VARIABLE SPEED MOTORS IN RAILWAY MACHINE SHOPS.

BY J. C. STEEN.

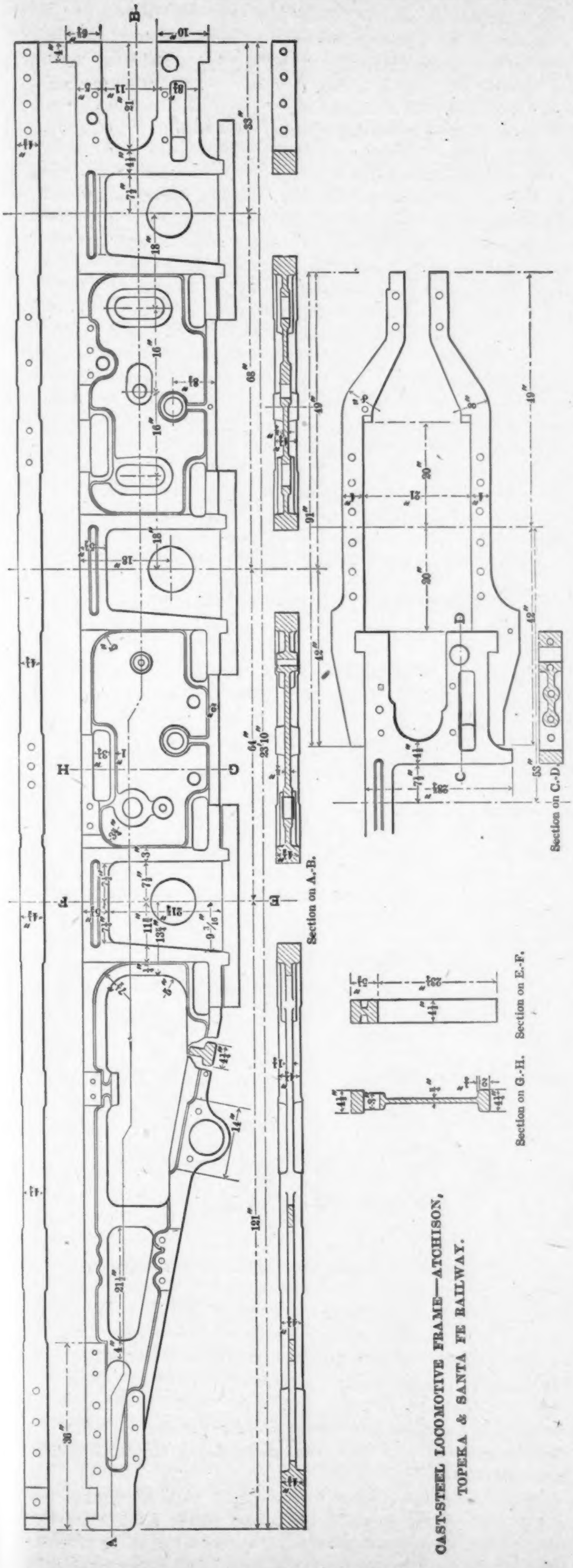
After considering the advantages of the variable speed motor in a general way, it remains to consider more specifically its adaptability for driving the various machines found in the railway machine shop. There are so many different types of machines and some of them are used for such a variety of purposes, that it is necessary to consider almost every machine separately. To better show the advantages of a well-selected motor equipment as applied to the machine tool, it may be well to consider first the disadvantages of the usual method of driving by means of stepped pulleys and belts. The term "stepped pulley" is here used in preference to the more common term of cone pulley, or cone. In order to transmit the driving power required in the successful operation of modern machine tools it is necessary to use pulleys either of a large diameter or with a wide belt surface. In many cases, the diameter of the driving pulley is limited or fixed by the nature of the machine upon which it is used. The belt width may also be limited by the number of steps of the pulley in order to secure as large a number of speeds as possible, or by adopting such a width as can readily be shifted from one step to another. A belt that is light enough to be shifted easily may be too light to transmit sufficient power, while on the other hand a belt heavy enough for driving purposes may be very hard to shift. It is frequently the case that much time is lost because the operator will not change the belt position, when by so doing he might secure a higher cutting speed. It is true that in many instances where the cuts are quite short the time saved would not justify stopping the machine long enough to shift the belt, but if by some ready means of adjustment the desired increase in speed could be quickly obtained then in such cases a saving in time by the use of the increased speed could be effected. When the work involves cutting upon different diameters and at different rates of speed, every minute saved by reason of operating at an increased rate of speed is that much gained.

The worst feature, however, in connection with the use of stepped pulleys is not the difficulty of shifting the belt, but is the comparatively large difference or jump between the different steps of the pulley or in other words, the large variation between the speeds when the belt is changed from one step to another. To illustrate this, consider the pulley and gearing of a 24-in. lathe. A representative machine of this class may have a pulley the extreme steps of which will be in the ratio of 8 to 1, and it will probably have a back gear ratio of about 12 to 1. By this is meant that the range of speeds as effected by the use of the belt upon the extreme steps of the pulley will be in the ratio of 8 to 1 and that the range of speeds with the belt in any given position with the back gear in and out will be as 12 to 1. With this arrangement, and using a 5-step pulley, the diameters at which the cutting speed is uniform will be in about this proportion: 24 ins., 14 ins., 8.5 ins., 5 ins. and 3 ins. with the back gear in; and 2 ins., 1.25 ins., .75 in., .42 in. and .25 in. with the back gear out. With the lathe arranged for any given cutting speed, it is obvious that for any other diameters than those corresponding to the different belt positions the speed will be at either a higher or lower rate of cutting than that for which the machine is arranged.

Consider a piece of facing work with the cut started at a diameter of 24 ins. at as high a rate of cutting speed as is possible for that particular job, then the work will be run at a gradually decreasing cutting speed until a diameter of 14 ins. is reached, where by a change in the position of the belt the maximum cutting speed can again be brought into use; and so on through the different diameters until the cut is finished. In this case we have an average loss of time of about 20 per cent., due to decreased cutting speed alone, besides the time lost by making the requisite changes in the positions of the belt. By the use of the variable speed motor and a controller with a suitable number of steps, the speed can be brought up to the maximum by simply moving the controller lever at the proper time without stopping the machine. By such means a possible saving of time of from 12 to 20 per cent. can be effected, the amount of time saved, of course, depending upon the number of speeds provided for in the controller, assuming that it is placed within easy reach of the operator.

The stepped pulley drive is also at a disadvantage when turning shafting of different diameters, or similar work where a maximum speed must be obtained to produce the best results with high speed cutting steel. The increase in cutting speed between any two adjoining belt positions is equal to about 60 per cent. Thus it will be seen that if a piece of work is being turned out at a rate of cutting speed which is 20 per cent. below that which the tool is capable of, the next speed, which is about 60 per cent. higher, may be too high for the tool to stand, so that the machine must go on cutting at a loss of time that might have been utilized had a ready means of securing finer gradations of speed been at hand. Such gradations of speed can be secured by the use of a variable speed motor with a suitable controller. Practical experience has shown, especially since the high speed steels have been introduced, that the limitation of the stepped pulley in this direction causes very much more loss of time than is generally supposed, since it does not give as fine gradations of speed as are required by modern methods. The defects noted in the above cases will apply equally well to many other lathes, and also to such machines as boring mills and other machines where stepped pulleys are now used That certain defects do exist with the use of pulleys, that necessitate frequent shifting of the belt, is evidenced by the fact that substitutes are offered in a variety of change gear devices to overcome these objections.

For motor driving the variable speed motor with a controller having a comparatively large number of steps seems at the present time to offer the most satisfactory means of securing the large number of cutting speeds called for in some classes of work. Examples of special applications will be treated in articles to follow.



CAST-STEEL LOCOMOTIVE FRAME—ATCHISON, TOPEKA & SANTA FE RAILWAY.

CAST STEEL LOCOMOTIVE FRAMES.

A Rational Design.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Those who have made the closest study of cast steel for locomotive frames are of the opinion that the design should be made with reference to the fact that the metal is to be cast and is to meet the difficulties of shrinkage and shrinkage stresses. They do not cast a frame of large rectangular sections, exactly of the form of a forged frame. Good steel frames have been cast after the pattern of wrought frames, and that they stand so well in service is the highest testimony to the skill of the foundry, but, after years of experience, no one will claim that there is any advantage in rectangular sections.

In the accompanying engraving a design of cast steel frames for a 0-6-0 switch engine is illustrated. This has been worked out with special reference to the material and its well known tendencies. Tee and I sections prevail, and the fillets are of large radius. Between the driving axle jaws the plate form is used, the metal in the web being ¾ in. thick, with bosses located wherever they are needed. Sections taken along the full length of the cast steel portion are shown in sectional plan. Wrought iron is used for the front section and also for the pedestal binders. Readers may desire to compare this design with that of the Delaware & Hudson Company illustrated in this journal on page 365 in October, 1903.

PAINTING OF STEEL CARS.

Following is a report made before the recent convention of the Master Car and Locomotive Painters' Association:

It is the sense of this association that, in the construction and painting of steel cars, the following points are of vital importance to their preservation:

First—All flash or mill scale, rust, oil, grease and dirt should be entirely removed from all parts entering into the construction of cars before any paint is applied. We believe that this can be best accomplished by the use of the sand blast.

Second—During construction, all overlapping joints, wherever metal is placed upon metal, should be thoroughly coated with a heavy mixture of moisture repelling paint.

Third—The initial painting, being of the greatest importance, should be done in the best possible manner. The first coat should be applied immediately after metal has been sand blasted and before the cleaned surface can accumulate rust.

The material should be of an elastic nature and sufficient time should be allowed between coats for drying. It should be put on evenly in a workmanlike manner.

Fourth—We believe that not less than three coats should be applied to all exterior parts of body, including underframing, and two coats on interior of body; also all parts of trucks except wheels and axles.

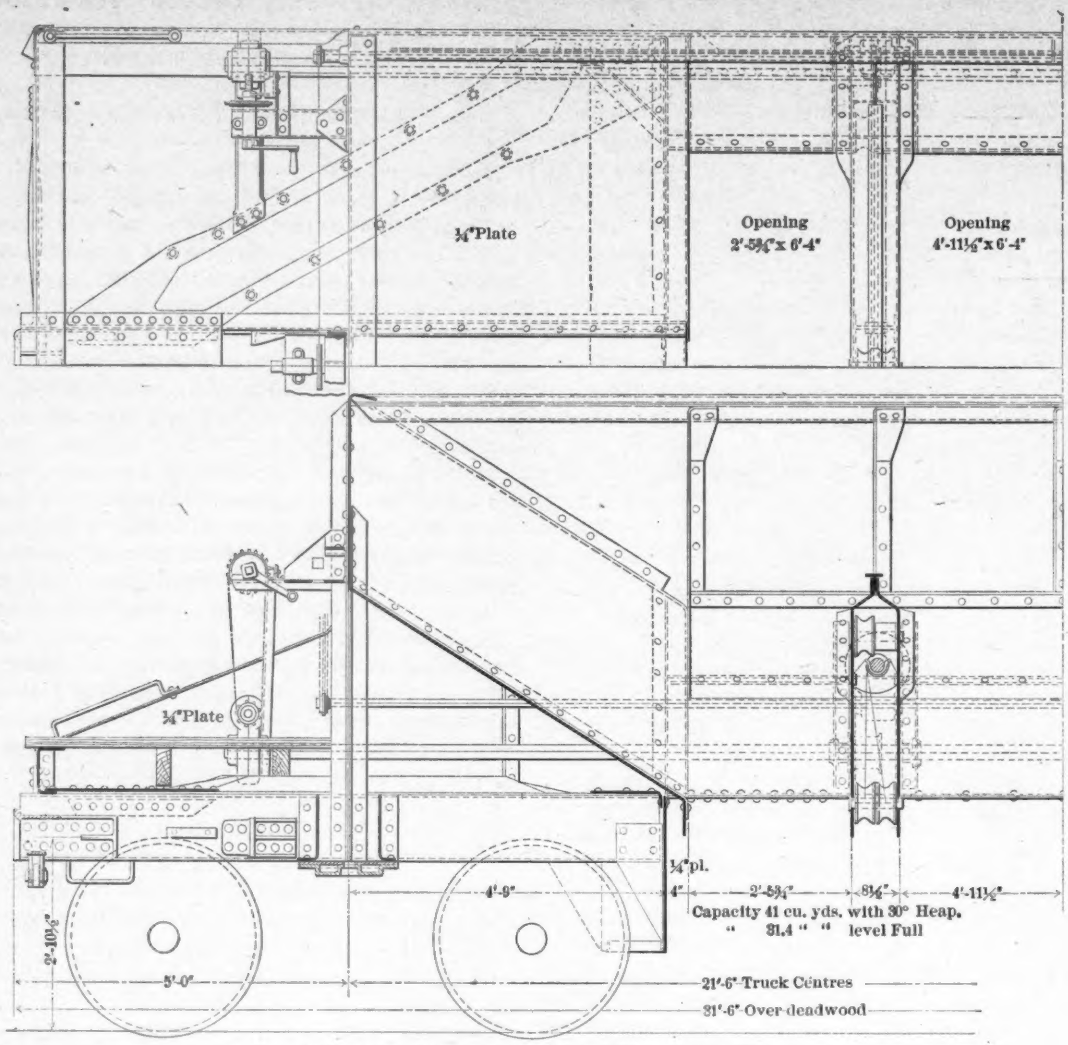
Fifth—We recommend a rigid inspection of the cleaning and painting of cars under construction by competent, practical men, believing this in the line of economy.

Sixth—We would suggest that the abuse of cars in service be stopped by discontinuing the loading of hot slag, billets, etc. Also that the hammering of side sheets and other injurious methods used to facilitate unloading be discouraged.

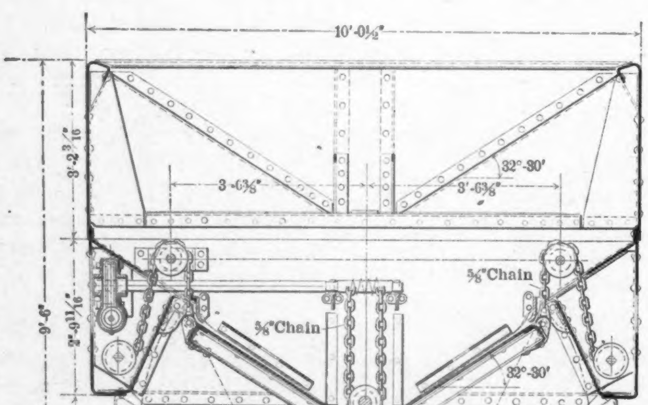
Seventh—In the repainting of cars, all corrosion and loose paint should be removed with steel scrapers and wire brushes or the sand blast, and not less than two coats of an elastic preservative coating applied to all cleaned parts.

As the greatest loss from corrosion is found on the interior parts of coal-carrying cars, we would consider the matter of painting those parts worthy of serious consideration.

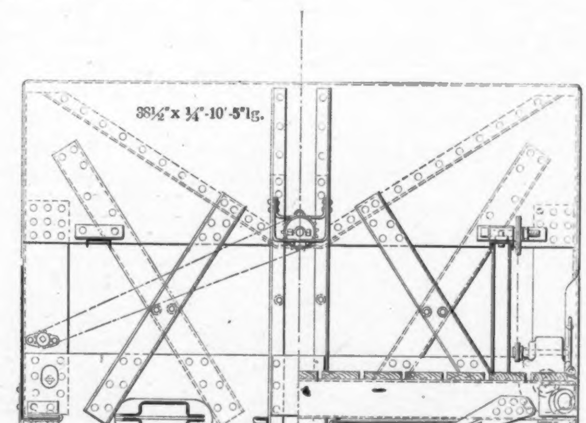
"Cross ties now cost more than twice the expense for rails."—*P. H. Dudley in the Railway Age.*



PARTIAL PLAN AND LONGITUDINAL SECTION.



CROSS-SECTION THROUGH CROSS-BEAMS.



PARTIAL CROSS-SECTION THROUGH PLATFORM AND END VIEW.

SUMMERS GRAVITY DUMP CAR.

THE SUMMERS GRAVITY DUMP CAR.

This car will dump its entire load on either side of the track or part on each side or all of it in the centre. The door openings are large and any load that can be handled by a steam shovel will pass out of them easily. The operator has full control of the flow of the material, as the doors will stand in any intermediate position between closed and full open, and ballast can be distributed in such quantities as desired while the car is in motion can easily dump the load and replace the doors.

Cars of the type illustrated have been in service since last June handling pig iron, broken stone, ashes, coal, blast furnace cinder, gravel and general refuse material. The average time for discharging the load was found to be about one minute. Loads of free running material are usually all out in from

40 to 45 seconds. One man can dump the load and replace the doors inside of two minutes. One of the large steel companies in handling refuse material from their mills found that it cost them about 7.2 cents per cubic yard to unload from the ordinary steel hopper cars. With the Summers car it cost less than this amount to unload the entire contents of 40 cubic yards, the difference being that the Summers car discharged its load to one side of the track where it was wanted, while the hopper car discharged it in the centre of the track and laborers had to rake or shovel it to one side.

Two large doors, which are interchangeable, extend from truck to truck and form the V-shaped bottom. Each door is supported by chains at both its inner and outer edges. The winding shafts for the chains are operated by worm gearing and no latch mechanism is required to hold the doors shut as the worm prevents the shaft from rotating except when operated by the cranks on the platform at the end of the car. The chains which support the outer edges of the two doors are operated independently and thus, if desired, the outer edge of only one door need be lowered and the entire load will be discharged on one side of the car; or the outer edges of both doors can be dropped at the same time and half the load discharged on each side of the car; or the inner edges can be dropped and the entire load be discharged between the tracks. No portion of the car is beyond the clearance lines either with doors open or closed. The various positions which can be taken by the doors are shown by the dotted lines in the cross section, and it will be noted that when the lading is unloaded at the sides it is discharged clear of the tracks. The chains and shafting are protected from the lading by the box construction of the lower side of the girders and by the cross beams. The vertical fender plate at each end of the door opening plows the material away from the track when making a side dump.

The design of the car is unique in that it has no center sills and the entire load and the stresses due to pulling and buffing are carried by the side girders. These side girders are deep and have a large top flange area and a heavy boxlike construction at the bottom. They are securely tied together by the two deep crossbeams. The pulling and buffing stresses are transmitted to the side girders through the diagonal pressed steel stiffeners and the bolster construction. The construction of the diagonal stiffener is clearly shown in the plan view and in the cross section taken near the end of the car through the platform. The draft sills are assisted in resisting the vertical downward component due to buffing forces by the end sill construction. The end sill is riveted at its ends to the extension of the side plate. The coupler carrier of cast steel is held in place by two large pins which fasten it to the cast steel arms which are riveted to the pressed steel end sill channel, thus forming a strong truss.

Mr. Summers' friends were very skeptical when he proposed to build a car without centre sills, but a gondola and a hopper car of his design, without center sills, have been in the most severe service since June, 1902, and have shown no sign of failure.

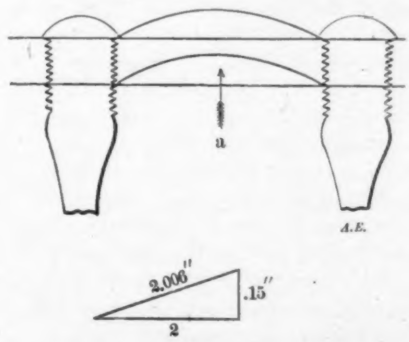
The gravity dump car described above has a capacity of 100,000 lbs., or 40 cubic yards; is 31 ft. 6 ins. long, 9 ft. 6 ins. high and weighs 39,600 lbs. It is patented by Mr. E. W. Summers of Pittsburg.

BULGING AND CRACKING OF FIREBOX SHEETS.

Two explanations are usually advanced to account for the bulging and cracking of firebox sheets in service.

First—That the bulging is caused by gradual burning of sheets in service at points at which the heat is concentrated or at which incrustations form.

Second—That the bulging and cracking is caused by the strain put upon the sheet by the contraction of the mud ring, while the upper portion of the firebox is still hot, the unequal strain causing the sheets to bulge and crack.



THE BULGING OF FIREBOX SHEETS.

No doubt cracking and bulging will result from either or both of these causes, though in very few instances are the sheets subject to a slow process of burning, for tests of metal cut from the bulges show very little deterioration. When the strains induced by the expansion and contraction of the sheets are considered, surprise is excited, not because the sheets crack, but because they do not always crack. If the sheet rapidly transmits the heat to the water and assumes the same temperature—about 375 degs.—the expansion between stays of 4-in. centers would be $375 \times .000007 \times 4 = .012$ in. This is apparently slight, but if the stays held the plate perfectly rigid it would cause the plate to bulge $\sqrt{2.006^2-2^2} = .15$ in. The metal would be strained beyond its elastic limit and would be permanently deformed. The pressure equivalent to this amount of bulging on a ⅝-in. plate with stays 4-in. centers has been shown by the United States Testing Board to be about 1,400 lbs. per square inch. When the boiler is cooled the load is removed and the sheet contracts, putting the fibers at "a" in compression. It is for this reason, namely that the sheets are alternately in a state of tension and compression, that the cracks frequently start from the water side. Anything that causes the localization of heat at one point, such as an arch, or that prevents the rapid transmission of heat, such as scale or poor circulation, will greatly increase these strains, for under such conditions the fire side of the sheet may be of a higher temperature than the water side. The fire side would therefore expand more than the water side and bulge the sheet toward the inside of the box. It is because the side of the firebox transmits heat less effectually than the crown sheet that the cracking is largely confined to the side sheets.

If one portion of a side sheet is suddenly cooled at 75 deg. while another portion is at 375 degs., this would be equivalent to inducing a tensile strain or direct pull of an amount above the elastic limit of the material, or about 30,000 lbs. per square inch of metal, and it would be but a question of a short time when a plate so strained would bulge and crack. The stretch per inch required to pass the elastic limit can be determined by Hook's Law, $E = \frac{p}{e} = 28{,}000{,}000$, if $p = 28{,}000$ at the elastic limit the stretch per inch would be .001 in. If, therefore, a firebox 10 ft. long is cooled so that one portion of the side sheet contracts .12 in. more than an adjacent portion, the steel will be strained to its elastic limit, and the repetition of these strains would soon rupture the plate. A crack so produced can start either from the water side or from the fire side, for sudden cooling not only induces tensile stresses such as these, but also stresses in flexure by bulging a plate rigidly held. These stresses are of about the same amount as those produced by the method first considered, but they are much more harmful in that they are suddenly applied. The probabilities are that cracks following bulges caused in service will start from the water side, whereas those caused by sudden cooling in washing out may start either on the firebox or water side.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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"A gas pipe and a drift will make a tight enough locomotive flue if the conditions are favorable when a tube of gold, diamond studded, cannot be made tight if the conditions are unfavorable," said a prominent superintendent of motive power to the writer who recently asked concerning his practice in flues. This official has had a hard time with flues because of the way his locomotives are overloaded, and he says that there is no way to overcome the difficulty except to reduce the weight on driving wheels so that locomotives cannot start loads which are too heavy for their boilers. There is food for reflection in this suggestion.

IMPROVEMENT IN ROUNDHOUSE EQUIPMENT.

To empty a locomotive boiler, do 18 minutes' work on the boiler, fill it, fire up and get the engine out of the house under its own steam at a pressure of 75 lbs., and do all this in 80 minutes, is a notable achievement, which has an important bearing upon future roundhouse practice and locomotive operation. How this is done at the McKees Rocks roundhouse of the Pittsburg & Lake Erie is described in a paper by Mr. A. R. Raymer, which appears in this issue. Mr. Raymer has done a signal service to the railroads of this country in the development of this system of boiler filling, washing and blowing out, in which the water for filling the boilers is brought to a high temperature by heat which would otherwise be wasted. The system has already been used long enough to demonstrate its success, but its possibilities for accelerating service at locomotive terminals and for reducing boiler repairs are probably by no means fully stated in the paper. Because the roundhouse is the key to the chief question of locomotive operation, any factor tending to improve facilities for prompt movement, as this does, should have immediate recognition by railroad managements.

PASSENGER CAR VENTILATION.

To Dr. Charles B. Dudley, chemist of the Pennsylvania Railroad, the credit for the greatest improvement in passenger car ventilation is due. With the assistance of the staff of his own and other departments he has pursued investigations during the past ten years which have resulted in the adoption and general use by the Pennsylvania Railroad of a system which has proved satisfactory and successful.

Through elaborate experiments the principles of the problem were established and the possibilities determined. Then a system was planned and put into experimental service with such success as to lead to its application to 800 passenger cars on the lines east of Pittsburgh, to its use on all new cars, and application to the older equipment as it passes through the shops. It has also been applied to 200 cars on the Pennsylvania Lines west of Pittsburg and to some of the equipment of the Baltimore & Ohio and other roads.

The system has not yet been applied to sleeping cars, but at the present time it marks the most important development in the improvement of car ventilation.

Dr. Dudley has just issued a pamphlet illustrating and describing the system, which contains the substance of his valuable articles in the AMERICAN ENGINEER in June, 1900, page 191, and June, 1901, page 177, and bringing the practice down to date as it is applied to the large number of cars referred to. The preliminary investigation and application were so thorough as to render few changes necessary, and Dr. Dudley's articles, written three and four years ago, very closely represent present practice as it is being introduced on a large scale to-day.

SHOP SUPERINTENDENTS AND MASTER MECHANICS

Superintendent of Shops is a title which is growing more frequent in the lists of mechanical officials of railways. It is becoming more necessary to divide and specialize the responsibilities of the subordinate mechanical officials most important in such a way as to permit of the possibility of administering their work to advantage. The time for expecting a master mechanic of a division to look after a large shop employing 3,000 men, properly supervise the work of engineers and firemen on the road, adequately direct running repairs and handling engines at three or four large roundhouses, and at the same time spend from one-third to one half of his time in entertaining grievance committees, has passed and will never return. In the old days, one man could do all this for a 200-mile division and readily maintain the standards which were set for him. It is beyond the capacity of any one to meet the requirements of such a division on a busy railroad to-day. The wisest course, and one which is rapidly growing in favor, is to divide the work so that the maintenance and operation of locomotives on the road is entirely separate from the problems of the shop. While one officer may be held responsible for the whole and may be called master mechanic, the superintendent of the shop is an absolute necessity.

The situation is clearly represented in the cost of a modern railroad shop, and the amount of investment involved in mistakes in construction, arrangement, equipment, organization and operation. It is very difficult today to find master mechanics who can handle both branches of their work equally well, and there are sufficient indications of the importance of considering them entirely separately.

There is also another side to this question, which applies on all roads with sufficient business to justify the separation. In educating men for higher positions those who are to take charge as superintendents of shops must have their training in the shops, and those for outside operation must have their training in connection with the roundhouse. A man in control of both will either be a good road man and weak as to shops, or a good shopman and deficient as to the road service. Road work is distasteful to many shop men, and is not good ground for preparing shop superintendents. With the separa-

tion of the responsibility the locomotive engineer has an opportunity to become master mechanic in charge of a division through the line of promotion to road foreman of engines and roundhouse foreman. The machinist in the shops may work up through the grades of foreman and general foreman to become the head of a plant. The divisional scheme promises a valuable advantage in offering means for training men in different lines for something better, and this is an important element for consideration of plans for meeting present conditions and improving service. Of course, this discussion concerns only the organizations which obtain on roads on which the motive power department has charge of the engineers and firemen.

EDUCATION FOR SHOPMEN AND ENGINEMEN.

A request for a list of books, information concerning valve motion models and suggestions helpful in inaugurating a school, has just been received from members representing a lodge of the organization of the mechanical employees of a well known railroad. The letter modestly apologizes for the trouble caused and expresses the earnest purpose of the lodge to improve by special study of the locomotive in order to increase the value of the service of its members. Who could consider it "trouble" to help in any possible way men who show such a spirit and desire to advance? The officials of any railroad should be ready to meet such a desire for knowledge with the greatest alacrity and with every possible encouragement, as will be done in this case.

But why wait for the men themselves to open such a question? Why should not every railroad take the initiative and then meet the men more than half way in such a far-reaching matter? It would cost perhaps a couple of hundred dollars to provide an attractive reading room for shopmen and enginemen at every locomotive terminal. Good valve motion models, a few good books and the best periodical literature could be provided for almost nothing, and the men would doubtless be anxious to contribute to the cost. In the case of the lodge mentioned, the men ask nothing but advice. They propose to bear the whole expense of a school, and the lodge will pay the bill.

Suppose the cost of the model and books and room to amount to $2,500 per year for ten roundhouses on a large road where a thousand or more well intentioned men would congregate. Suppose ten firemen only should make a careful study of combustion and as many engineers should study boiler construction, these men alone would pay several thousand per cent. interest on the investment by the improvement of their work and care of their employers' property.

At the recent conventions at Saratoga the mention of the "Fireman" brought many speakers to their feet to say that it is impossible to secure good men to fire big modern locomotives. Not long ago a railroad president said that it was impossible to get the right sort of men to run big locomotives. It may therefore be accepted as a fact that something must be done or the advantages of the big locomotive will be lost. What better opportunity for improvement offers than that of education? What better indication could be found for the need of education when the demand comes from the men themselves?

This is a subject of transcendent importance to the American railroads, and one in which directors should take a vital interest. They cannot afford to miss such an opportunity as lies before them through education. The writer ventures the prediction that railroads meeting this demand unreservedly and unstintingly will have more educational committees and fewer grievance committees.

In these paragraphs books and reading rooms are suggested. Why stop short of well equipped and well conducted schools?

Railroads should be builders of men as well as of tracks, locomotives and cars. They can not find competent men ready made, and the difficulties are increasing. If the Master Mechanics' and Master Car Builders' Associations should also become Master Men Builders' Associations they would meet a great need of the times. They should build shop men, foremen, firemen, engineers and all kinds of men. The British Admiralty a generation ago found it necessary to educate its own men, and now the educational work is placed under the direction of an official who has no other responsibilities. Our railroads must do something of this kind, through schools of their own or through co-operating with existing educational facilities.

AN IMPORTANT VIEW OF ELECTRIC TRACTION APPLIED TO STEAM ROADS.

The problem of applying electricity to steam railroads has been attracting considerable attention, not alone from visionaries, but from men in active charge of the steam roads. The following is one of the most calm and intelligent expressions that we have seen on this subject and comes from Mr. Bion J. Arnold, whose opinion on this question is most highly regarded.

The amount of energy transmitted to any great distance and used by electric cars that have been put in use until recently has been small when compared with the amount of energy that it takes to propel a steam railroad train of 500 tons or 600 tons weight at the speeds ordinarily made by such trains. It may be taken as axiomatic that, when investment is taken into consideration, power cannot be produced in a steam central station, under conditions that exist to-day, and transmitted any great distance to a single electrically-propelled train requiring from 1,000 to 2,000 h.p. to keep it in motion, as cheaply as a steam locomotive, hitched directly in front of the train, will produce the power necessary for its propulsion. Therefore, there must be other reasons than the expected economy in power production, to warrant the adoption of electricity on a trunk line railway, unless it can be shown that the trains are frequent enough to make the saving in the cost of producing power greater than the increased fixed charges made necessary by the increased investment due to the adoption of electricity.

That electricity will be generally used on our main railway terminals, and ultimately on our main through lines for passenger and freight service, I am convinced, but I do not anticipate that it will always be adopted on the grounds of economy in operation. Neither do I anticipate that it will come rapidly or through the voluntary acts of the owners of steam railroads, except in special instances.

At first the terminals will be equipped for special reasons. Those roads which run through populous countries will either build new roads or acquire, for their own protection, those electric railroads already built and operating in competition with them, and utilize them as feeders to their through line steam trains. The next step will logically be the electrical equipment of the trunk lines between the cities already having electrical terminals.

With the terminals and main lines equipped electrically and the desire on the part of the public for more prompt and effective freight service, resembling that which is given by the steam roads in England and on the Continent, due to the great density of population, there will be developed a great high-class freight service, conducted in light, swiftly moving electric trains, which can be quickly divided and distributed over the surface tracks of our smaller cities, or through underground systems similar to that which is now being built in Chicago. Such a system would soon prove indispensable to the public and a source of great profit to the roads, as it is now getting to be to many suburban railways.

Until recently the cost of electrically-equipping a trunk line under the standard direct-current, rotary-converter system has been such as to practically prohibit its adoption, but recent developments in the single-phase alternating-current motor field have made it possible to eliminate a large part of the investment heretofore necessary, and the prospects for the application of electricity to long-distance running are better than ever before.

I do not anticipate that all roads will soon adopt electricity, for the steam locomotive will hold its field in this country for

many years to come, but I do expect, judging somewhat from "positive knowledge," a remarkable development soon to begin in the electrical equipment of favorably located steam roads.

These extracts are taken from an address before the International Electrical Congress at St. Louis.

RAYMER'S BOILER WATER CHANGER.

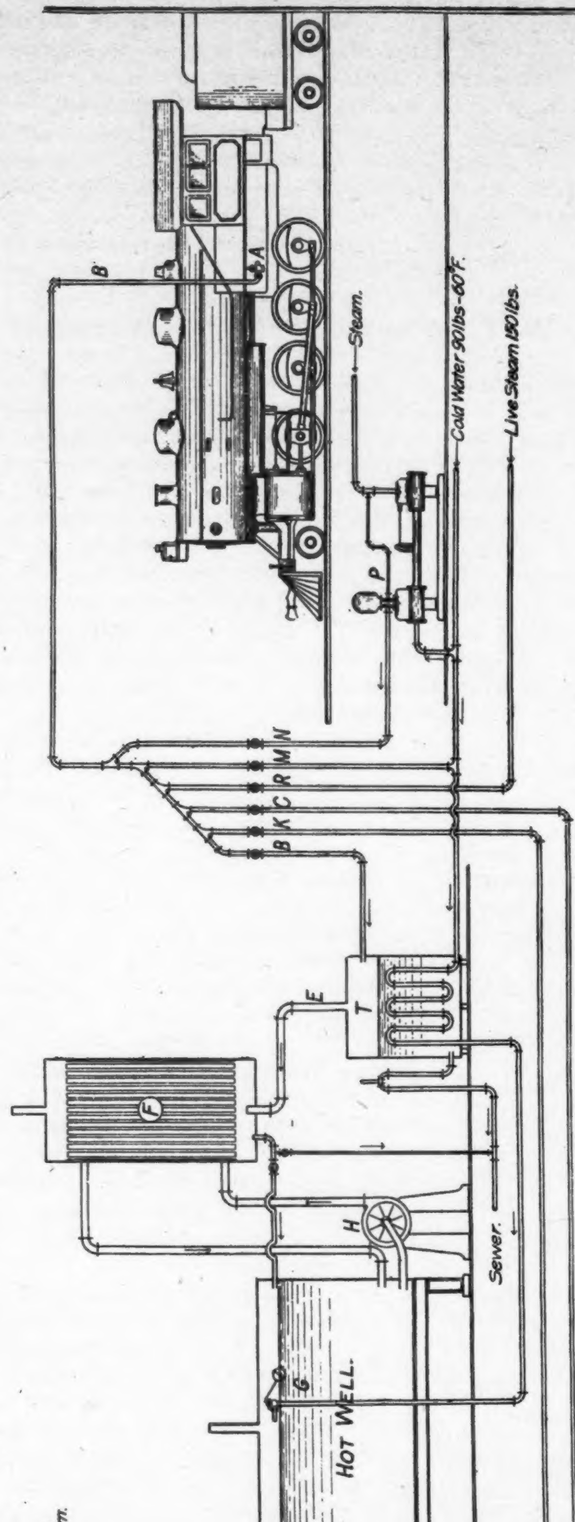
A series of five articles describing the extensive water softening installation on the Pittsburg & Lake Erie Railroad appeared in this journal beginning with the November, 1903, number. An important feature in connection with this installation is the boiler water changer at the McKees Rocks roundhouse. The following description of this is abstracted from a paper read by Mr. A. R. Raymer, assistant chief engineer of the road, before the Western Railway Club.

This plant has been in successful operation since November, 1903, and by it the foul water is removed from locomotive boilers; the heat is saved and used in heating the water for refilling, and the boiler is refilled with water having a temperature of about 300 deg. F.; the whole operation requiring from 20 to 35 minutes, depending on the size of the boiler. If the boiler at the commencement of the operation shows a steam pressure of 100 to 125 lbs. per sq. in., and if the fire is banked, which is desirable, the steam pressure during the process will not fall below about 75 lbs. per sq. in. This water change is made without allowing any steam to escape in the atmosphere, and also without discharging any water on the floor of the roundhouse or into the pits. While it is being done the temperature changes in the boiler are very slight, being not more than 30 deg.

On many and a rapidly increasing number of roads there exist conditions which make it desirable to "change" the water much oftener than it is necessary to remove the plugs to wash out mud or scale. The list of these roads will include those that use water having alkaline and other soluble compounds that are not precipitated in the form of scale in the boilers; others that use waters that make a small quantity of scale that does not cement or adhere to the metal, and lastly the rapidly increasing number that have awakened to the importance and economy of purifying the water, by removing all scale forming solids and mud in suspension, before the water is delivered to the locomotive boilers. The condition of the water on the P. & L. E. R. R. is such that it is necessary to remove the plugs for washing only once in from 20 to 45 days; during this time the water is changed whenever necessary, or on an average of about once each five days.

The benefits resulting from the use of treated water, in comparison with the conditions existing when the locomotive feed water was used in the raw condition as pumped from the rivers, are clearly shown by a few facts taken from the records. *a*. Number of trains given up on the road on account of leaking boilers during August, 1902, 27; during August, 1904, 2. *b*. Number of trains that had to reduce the loading by setting off cars, on account of boilers leaking, during August, 1902, 13; for August, 1904, none. *c*. Number of through trains during August, 1902, with delays of 1 hour or more, that had locomotives changed at McKees Rocks, on account of boilers leaking, 31; for August, 1904, 3. Similar comparisons can be made from results already obtained which show enormous advantages in favor of using purified water, in the increased life of flues, fireboxes, etc., in the reduction of boilermakers' wages and in the increased service obtained from the locomotives and the reduction of the amount of fuel used.

By use of the plant here described, locomotives requiring a change of water have their fires cleaned in the usual way and are sent to roundhouse preferably with fires banked and steam pressure at about 100 to 125 lbs. Blowoff cocks have been placed on the left side of the firebox near the bottom. An overhead 2½-in. blowoff pipe is located between engine pits, with a pipe coupling located about 6½ ft. above the floor and opposite the blowoff cock in boiler, when the locomotive is in proper position in roundhouse. The other end of the blowoff pipe con-



DIAGRAMMATIC VIEW OF RAYMER'S BOILER WATER CHANGER.

nects with a manifold on the wall of roundhouse (see diagram). A flexible pipe with necessary joints, gauge, drip cock and extension pipes for reaching blowoff cocks is mounted on a light truck for convenience of operation. This minutes. When the water is all blown from boiler the blowoff cock, and connected therewith, and also with the blowoff pipe overhead, after which the valves are opened and the water in the boiler is forced out by the steam pressure in 10 to 20 minutes. When the water is all blown from boiler the blowoff valve in the manifold is closed and the superheated water (at temperature of 300 deg F., and with pressure of 125 lbs.) valve is opened in same manifold and the boiler is quickly refilled with this pure water, after which the valves are closed and the flexible pipe truck is disconnected and removed. During this process there remains in the boiler a steam pressure of about 75 lbs. after foul water is fully removed and the pure water is forced in against this pressure.

Manifolds are placed on the roundhouse wall, one for each of as many pits as it may be desired to serve; pipe mains are laid under the floor in an accessible trench, one for each branch of the manifold. It has been found desirable to have the manifolds include the following service pipes: Live steam at about 150 lbs. pressure; blowoff pipe; superheated water, at temperature of about 300 deg. F., and with pressure of about 125 lbs.; hot water, at a temperature of about 200 deg. F., that is the hot well temperature, and with a pressure of about 125 lbs.; cold water, at supply temperature, say about 50 deg, F., and at about 90 lbs. pressure; test water, at supply temperature and at any desired pressure up to 300 lbs.

Live steam is used for heating up empty cold boilers, which can be safely done in about 10 minutes, in which time the temperature is changed from cold condition up to about 300 deg. F. The action of the steam on the empty boiler shell is uniform throughout its mass and consequently causes no unequal expansion, and therefore no bad results. Live steam is also used for increasing the temperature and pressure in a boiler full of water and under low steam pressure. The blowoff pipe from the manifold is used to convey blown-off water and steam to the blowoff tank. Superheated water is used for refilling boilers when water is changed and for filling empty boilers after they have been warmed up by use of live steam. Hot water is used for filling boilers when hydrostatic test is to be applied by test water at proper pressure; hot water is also used to cool down boiler shells quickly and safely. Cold water is used for removing mud, scale, etc., when necessary, by old way of washing. Test water is used as described above for making hydrostatic tests; this is furnished by a pump set to the pressure desired.

The blowoff pipe B (see diagram) attached to blowoff cock A conveys water and steam from boilers to blowoff tank T, which tank is closed and furnished with a pipe E to convey steam to condenser F, and if in excess to the atmosphere; the superheated water and steam blown from the boilers will therefore immediately on arrival at blowoff tank drop to a temperature of 212 deg. and all heat above that amount will pass in form of steam through pipe E to condenser. A hot well is located near and below the condenser; it is kept full of pure water from the supply by means of a float valve G. This supply water for hot well flows through a coil in the blowoff tank, thereby extracting considerable heat from the foul water left therein, reducing its temperature below 212 deg. A centrifugal pump H draws water from the hot well and circulates it through the condenser F and back to the hot well, thereby condensing the steam and transferring the heat to water in the hot well. The water of condensation also flows from the condenser to the hot well, or to the sewer as may be desired. A hot water pump J is located below the hot well level and draws water from it and forces it by pipe K to the hot water valve in manifold, and by pipe C through a live steam heater L to the superheated valve in manifold. This pump is set for constant pressure of 125 lbs. and is controlled by a steam pressure regulator. The test pump P is of the usual steam pressure regulated type easily adjusted for the pressures wanted, up to 300 lbs. per sq. in.

Few persons who have not made this work a special study will appreciate the amount of heat lost when an ordinary locomotive boiler is blown off and no attempt made to save it. An ordinary freight locomotive boiler will hold about 2,500 gals. of water when in working condition, and the amount of heat blown off from a boiler of this kind at 100 lbs. pressure will evaporate about 2,700 lbs. of water at 212 deg. F. and this amount of heat along with that saved from the foul water is sufficient to raise the refilling water from an initial temperature of say 60 deg. F. up to 200 deg. F. In delivering this refilling water to the boiler at say 300 deg. F., the additional heat above that of the hot well, which is at about 200 deg. F.. is furnished by live steam from stationary boilers. No one will question the economy of drawing heat from a modern power house with stokers and high efficiency boilers rather than trying to heat up locomotive boilers in the old way by smoky fires, with expensive draught furnished by use of compressed air or steam.

Following is a fair example of the time required to change the water in a heavy consolidation locomotive.

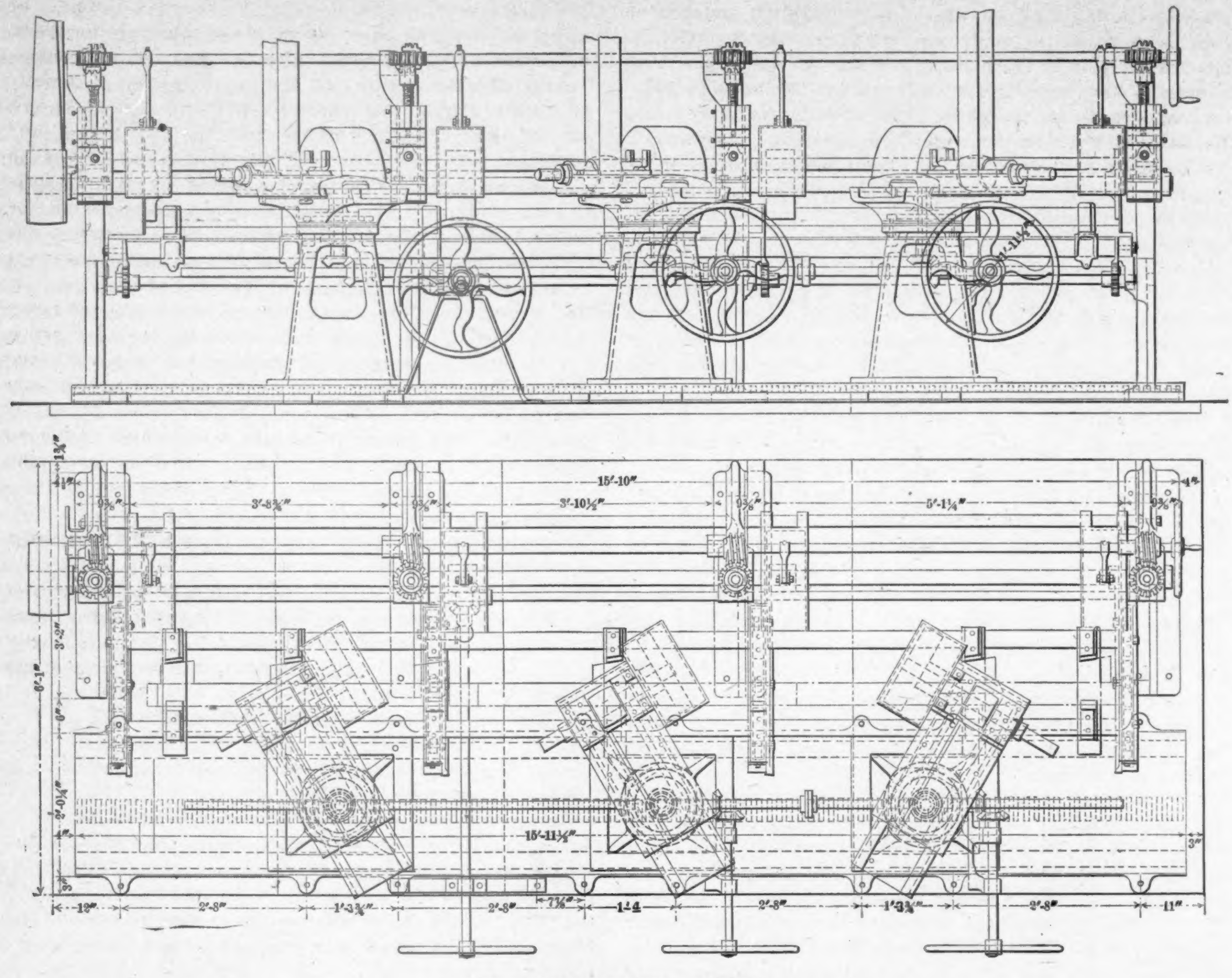
Fire was banked with steam pressure at 112 lbs., water change was made in 37 minutes, and steam pressure did not fall below 50 lbs.

4.00 p. m.	Commenced to blow off water, boiler pressure 112 lbs.
4.24 "	Water all out; boiler pressure 90 lbs.; continued blowing steam.
4.26 "	Stopped blowing; boiler pressure 50 lbs.
4.27 "	Commenced filling with superheated water.
4.37 "	Boiler showed 2 gauges, and pressure of 75 lbs.
4.40 "	Locomotive left roundhouse.

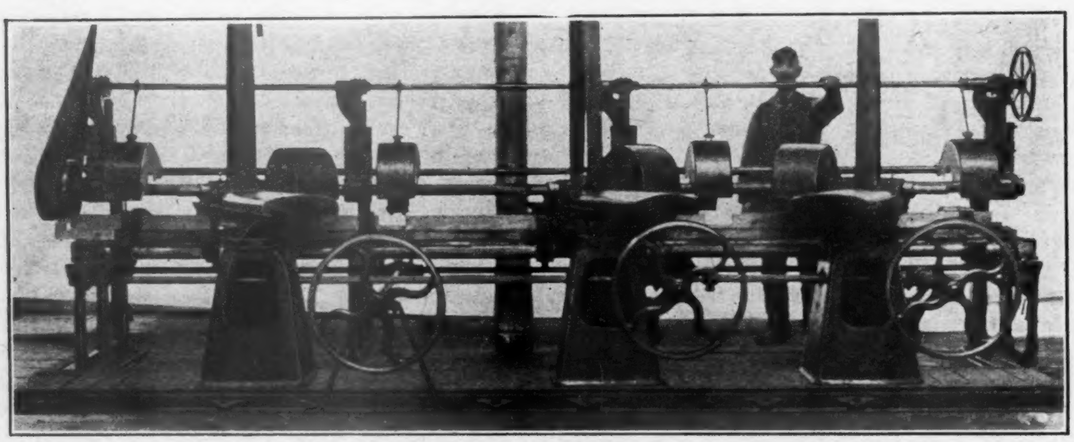
One man in the roundhouse at 18 cents per hour does the work of changing water in boilers, heating and filling boilers, testing, etc., and he can handle two locomotives an hour, if they are delivered to him so that he can operate on two or more at one time. At the McKees Rocks roundhouse there are 10 stalls equipped for the use of this plant, and 4 trucks are used in making the connections to the boilers.

In conclusion, some of the advantages resulting from the use of the above plant have been found to be as follows: Work of filling and emptying boilers and of changing the water is done without causing destructive strains in them. The roundhouse work on boilers is more economically done in regard to labor, fuel and time. Locomotives can be and are maintained in better condition, as work can easily be done when needed, on parts of the boiler, not accessible without removal of the contents. The roundhouse conditions can be much improved, the floor will be cleaner and dryer, and the air will be free from smoke and steam, much to the benefit of the employes and of the structure. Great economy resulting from the amount of heat saved from the water and steam blown out of boilers and used in heating water for other boilers. Convenience of method of making hydrostatic tests of boiler strength, and the thoroughness of the operation results in the boilers being maintained in safer condition. On account of the quick service in roundhouse work, passenger locomotives are run on schedules, with shorter time at terminals, thereby increasing the amount of work that can be done by the locomotives.

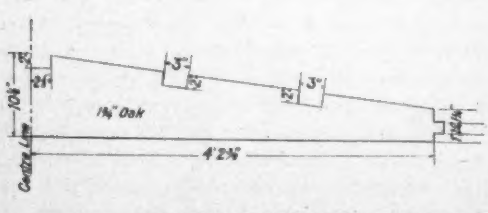
Personally, I do not believe that the alternating-current motor will make very serious inroads in the field now occupied by the direct-current railway motor. I do not believe that the direct-current railway system will be changed to any extent into the alternating-current railway system; but, what I expect of the alternating-current railway motor is that it will find and develop a field of its own, that field which the direct-current railway motor cannot reach—interurban service, long-distance service, secondary railway service.—*Dr. C. P. Steinmetz, International Electrical Congress.*



BELT RAIL CHECKING MACHINE.



BELT RAIL CHECKING MACHINE.



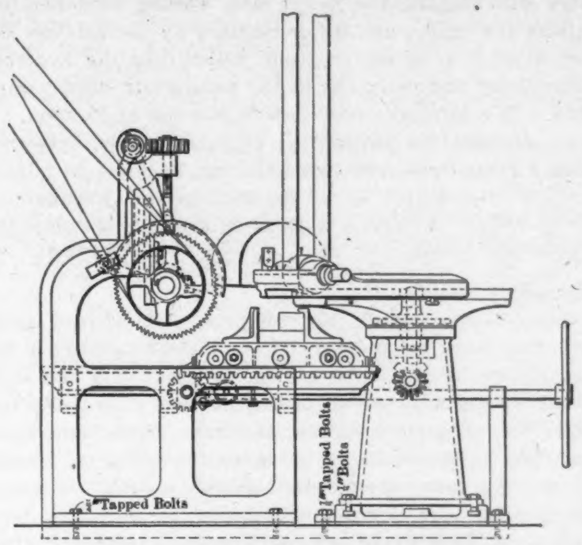
ONE-HALF CARLINE, SHOWING WORK DONE IN ONE OPERATION.

TWO REMARKABLY EFFICIENT WOOD-WORKING TOOLS.

GRAND TRUNK RAILWAY.

In the car shops of the Grand Trunk Railway in Montreal are several wood-working machines, which have been in service for a number of years and embody labor saving principles which are worthy of special attention. Through the courtesy of Mr. William McWood, superintendent car department of this road, drawings and photographs of these machines are shown. The first is a belt rail checking machine. This machine is mounted on a cast iron bed. It saws belt rails to length by means of saws which are mounted on a shaft extending the

length of the machine and driven by a belt, shown at the left in the elevation and photographic views. This machine carries three inclined heads for gaining for the braces. These heads are set at the proper angle and are moved across the belt rails by the hand wheels, this work being done in the operation separate from that of the straight gains of the posts. The straight gains are made by cutters placed upon the same shaft with the saws. The photograph shows a belt



BELT RAIL CHECKING MACHINE—END VIEW.

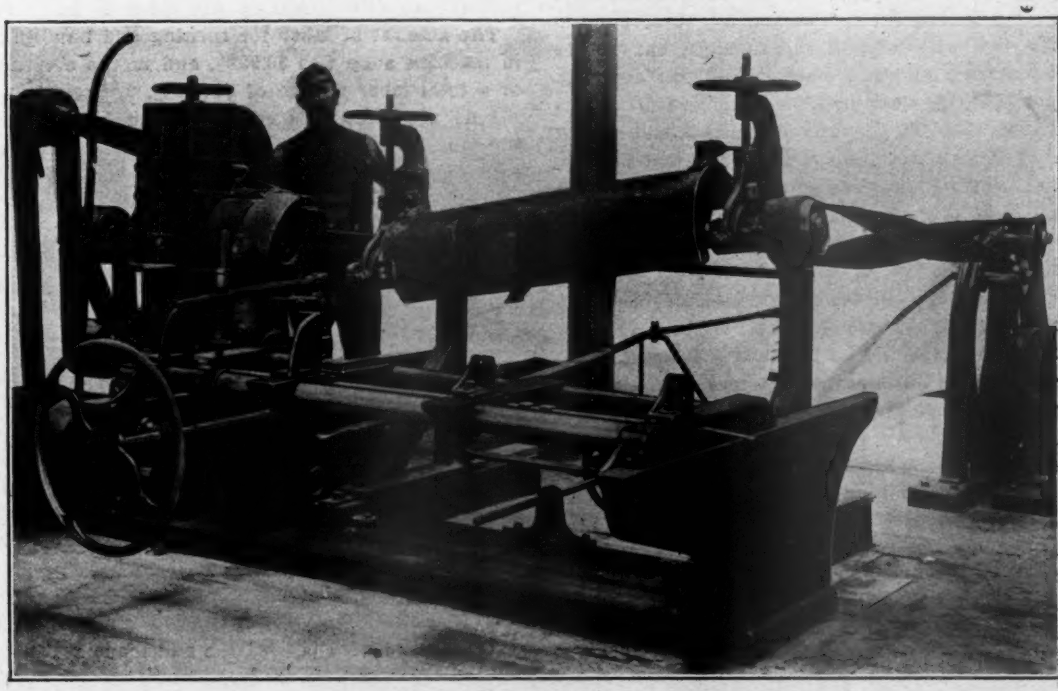
on the other side, to take care of the different slopes each side of the center of the carlins—that is to say, it would be possible to build a machine which would complete the operation in one cut, but as this machine turns out, on an average, 120 carlins per hour, with one man and a helper, it is quite sufficient for present requirements. The changing of knives, or cutters, is accomplished by loosening one bolt in each, and the changes can be readily made, for any requirements, in fifteen minutes. As the photograph shows the machine without carlins in place, a sketch has been added showing the work to which this machine was set when the photograph was taken. It is obvious that the possibilities of this arrangement of machinery, as to variety of work, are very great.

While neither of these machines are new they have never been illustrated, although Mr. McWood has generously supplied drawings to other railroads for construction of similar machinery for use in railroad shops where a large number of cars are built and repaired.

We are indebted to Mr. S. S. Underwood, chief draftsman of the department in Montreal, for informaiton concerning these machines.

CORRUGATED BOILER TUBES AS SPARK RETARDERS.

Interesting information in a letter from a superintendent of motive power who is using spirally corrugated boiler tubes under the very severe conditions imposed in connection with the burning of lignite fuel in locomotives is presented in the following quotations:



CARLINE MACHINE.

rail in place, having been sawed to length and gained for posts and braces. Belts for the angle knives, for the brace gains, run to the countershaft with a continuous pulley overhead extending the full length of the machine, in order that any change of angle, or shifting of the knives, may be accomplished without removing the belts. This machine turns out about 220 belt rails in ten hours.

The other machine is a combination tenoning and checking machine for carlins. This machine is illustrated by a photograph only. It consists of an ordinary tenoning machine with the additional shafts and knives shown in the photograph. The driving pulley on the end of the cutter shaft is almost a ball in form. In other words it is excessively crowned to accommodate widely different variations of angles to which the shaft may be set. This machine requires the carlins to be turned end for end, making two operations to finish the piece. This might be avoided by the duplication of the machine

"The spark problem is to us a very serious one. We run through a very dry agricultural country watered by irrigation and through a great deal of grazing country, and in either of these places a fire is a very serious matter. You have, no doubt, read about prairie fires, and if you have not seen them you have gathered that it means a great deal to people adjacent to the burned district.

"Through most of this section of the country we are burning lignite coal. I suppose you are aware that there have been many efforts made by Western railroads to burn this fuel, but with very poor success. I am not egotistical at all when I say I believe we have been more successful in burning this fuel than any one who has tried it and am satisfied that we can make further improvements along this line. One of the chief objections to the use of this coal is the amount of fire that is thrown from the stack. If you have never had any experience with it you can hardly appreciate what this means. It is like

burning wood or charcoal with a blast underneath the grates. We have used all sorts of appliances, but the best results are obtained from a big diamond stack with a big cast iron cone and very fine netting 4½ x 4½ mesh. The use of this stack means considerable back pressure, owing to the small nozzle that we have to use to prevent fires by throwing sparks against the cone with force enough to break them up so that all that will come through the fine netting will extinguish before reaching the ground.

"Our aim is to burn this fuel with an open stack and we are just now doing considerable investigating along this line. The engine in which the spirally corrugated tubes are placed is running successfully with an open stack and with a nozzle ⅜ in. larger than any we have been able to run with engines burning the lignite fuel. All the reports coming to me show that this engine throws less fire than any engine we have of the same class that is fitted with diamond stack. These diamond stacks are very expensive to maintain. They cost us approximately $1 a day for repairs and maintenance.

"What happens inside of these tubes I do not pretend to know, but it would seem to me that the sparks must get some kind of a rotary motion similar to a bullet going through a rifle barrel and this may perhaps twist the fire out of them. In any event, that they aid us in this respect we are quite sure and we have ordered sets for more engines of different classes so as to continue our investigations.

"I am getting very much interested in this lignite coal burning, and from sheer obstinacy I suppose, because so many have tried and failed. It means a tremendous amount of money to any railroad company using it. The other roads about here are watching us and telling their managements that our engines burning this fuel will not pull full tonnage, but we are managing to get over the road and make a very fair showing. The coal is 80 per cent. cheaper than bituminous coal in this country, but we burn about 60 per cent. more of it and in that way effect a saving of at least 20 per cent. in fuel and in addition to this do not have to take care of the ash. Perhaps you may be interested in seeing an analysis of this coal.

"Lignite coal analysis: Moisture, 20.6. Volatile matter, 32.4. Fixed carbon, 44.4. Ash, 2.6."

You will note the small amount of ash we have, and when we come to compare handling of this with the handling of other coal that costs the same it should be taken into account. One of the coals that we get on our line has 23.4 per cent. ash.

"I am very much interested in lignite coal burning and if the spiral corrugated tubes have any effect whatever in diminishing the amount of fire thrown from the stack of engines they are just what we want and I hope that the experiments we are making are going to enable us to determine whether or not there is anything in that. After a while I am going to fit up a number of engines with peepholes so we can get a view of the interior of the smokeboxes of some engines with and without these tubes and working hard."

It is to be noted that the increase in power required with the new tool steels is not so great as the increase in output secured. There are numerous instances where the work done has been more than doubled, while the power increase required has not been more than 50 per cent. The average consumption of power by carbon steels is usually 0.05 or 0.06 h.p. per lb. of metal removed per hour, and the new tool steels will require only 0.03 or 0.04 h.p.—*C. H. Benjamin in Cassier's Magazine.*

PNEUMATIC TUBES FOR BAGGAGE CHECKS.—At the Union Station in St. Louis a new system of transferring baggage checks has been installed. Baggage is taken from the train floor to a transfer floor below, by means of 17 special elevators. From here they are delivered to teams or transferred to outgoing trains. Checks are transmitted from the baggage room to 35 separate transfer stations by means of pneumatic tubes, comprising 8 miles of 3-in. brass tubing, capable of carrying 12,000 checks per hour during the rush hours.

COMMUNICATIONS.

TWO FAST RECORDS.

To the Editor:

The boiler for Union engine No. 81, which had been in the boiler shop to have firebox applied, was delivered to the erecting shop at 10.30 a. m. September 1. The erecting shop force, together with lagging and jacket men, worked until 4.50 p. m. in putting the engine and boiler together on the 1st, and from 7 a. m. to 10.15 a. m. on the 2d, at which time the locomotive was completed and delivered to the painters to have painting finished. The painters completed their work at 12 noon.

Time consumed in putting the engine together, 8 hours 45 minutes. Total time, including painting, 10 hours 30 minutes.

D. J. REDDING, Master Mechanic.
Pittsburg & Lake Erie Railroad Company.

McKees Rocks, Pa.

To the Editor:

A consolidation engine, No. 840, class W, arrived at our Portsmouth shops on October 1st with tires flattened 6 ins.; it was run into back shop at 5 p. m. the same date and at 6.15 p. m. the wheels were placed in the machine shop ready to be turned. We commenced turning the tires, which were 56 ins. in diameter, on October 2d at 7 a. m. and at 6.05 p. m., 11 hours and 5 minutes later, they were finished; we had to take off ¼ in., therefore reducing the diameter of the tires ½ in. At 6.30 a. m., October 3d, we commenced putting the wheels under the engine and at 11.30 a. m. it was turned over to the roundhouse with steam up and ready to go on its run.

The amount of labor for turning and handling these wheels in machine shop was $3.99½, and in the erecting shop $13.33, or a total labor charge of $17.32½.

I do not think this can be beaten both for the amount of time and labor; if so would like to hear from some one who has done it quicker. These tires could have been turned quicker with less labor if our traveling crane would have handled the wheels to and from the machine.

G. W. KELLER, General Foreman.
Norfolk & Western Railway Co.

Portsmouth, Ohio.

REPAIRING CRACKED CYLINDERS.

To the Editor:

In the October issue of your journal appeared an interesting article describing the repairing of a cracked cylinder at the Michigan Central shops, the reading of which reminded me of a novel method recently used at the C. R. R. of N. J. shops, at Ashley, Pa., which deserves recording.

The crack in this instance was in the side of the cylinder, one of the kind usually repaired by applying a piece of boiler plate, secured with patch bolts and made steam tight by caulking the edges of the crack or using some kind of packing. A piece of iron 1¼ ins. thick was turned about 8 ins. in diameter and cut into two semi-circular pieces. These two pieces were fastened by ⅞-in. patch bolts on either side of the crack, with a slight opening between them, and a band of iron was shrunk on over them, thus closing the crack tightly and making a steam-tight joint. The patch did not interfere with the jacket and appeared to make an effective and speedy repair.

EDWARD B. MCCABE.

SPECIAL APPRENTICESHIP.

To the Editor:

So much has been said in your journal of late in regard to the treatment of special apprentices that I want to record the fact that there is one road at least where they are well treated. I finished my course a few months ago and was immediately put on shop improvement work at the maximum rate of pay for machinists. You are at liberty to use this information without my name or the name of the road.

J. K. L.

WEIGHT OF PLATE SPRINGS.

To the Editor:

The following formula may be found useful for estimating the weight of plate springs:

Let l = length of longest plate when straight.
b = width of plate.
t = thickness of plate.
n = number of plates.
w = weight of band.
W = total weight of spring.
Then $W = .18 (l \times b \times t \times n) + w$.

w, the weight of the band can be easily calculated from its dimensions.

In deriving the constant, the actual weights of about 200 springs were used, varying from 150 to 600 lbs. The formula gave a weight within 1½ per cent. of the actual for all springs, and within ½ per cent. of the actual for springs in which the number of long plates was ¼ the total number. The weight of clip ends was found to have practically no effect on the formula.

L. H. SCHENCK.

NEW MOTOR DRIVEN CRANK SHAPER.

The 16-in. crank shaper shown in the half-tone has a two-piece crank motion, which gives a powerful, even cutting speed on the forward stroke and a quick return of 4 to 1. The method of driving from the motor by means of the belt is novel, and practical tests have shown it to be about as positive as gearing or a chain drive. The idler pulley is connected to the armature shaft by gearing, and thus both idler and driving pulley act as drivers. The idler is held on the bell crank, as shown, and can be raised until the belt makes almost a complete wrap about the driving pulley. The motor is a Storey 1½ h. p., variable speed, and the controller furnishes 26 steps by means of field control. As there are two runs of gearing, the ram has a total of 52 speed changes.

16-INCH CRANK SHAPER.—STOCKBRIDGE MACHINE COMPANY.

The ram is of box pattern, and has a bearing in the column 26 ins. long when at full stroke. The stroke can be adjusted from the front of the machine, and an index and pointer showing length of stroke are in plain view. The head which carries the tool has its swivel accurately graduated, and is rigidly clamped. The tool slide has a travel of 6 ins. with automatic feed. The table has a working surface of 10 x 11½ ins. on the top and one side, and has a cross feed of 22 ins., automatic in either direction. It has a vertical movement of 14 ins. by means of bevel gears and a telescopic screw with ball bearings. The vise has a graduated base that can be set to any angle, is clamped to the table by four bolts fitting in the T slots, and can be used on either the side or top of the table. The rocker arm is designed so that a 3-in. shaft can be passed through under the ram for key-seating. This shaper is made by the Stockbridge Machine Company of Worcester, Mass.

LOCOMOTIVE PRACTICE IN FRANCE.

Following is an abstract of a paper by Edouard Sauvage, presented before the International Engineering Congress at St. Louis.

The interest of French locomotive practice is centered in the development of the 4-cylinder compound, which has permitted a marked increase in the weight and speed of the trains. In the majority of these engines the high-pressure cylinders drive one axle, and the low-pressure cylinders another axle, but coupling rods have been preserved between these axles. The only exception is a unique locomotive (No. 701) built in 1885 for the Chemin de Fer du Nord, in which the two axles were not connected. This plan has not been continued. The use of coupling rods began in 1887 on the Paris, Lyons & Mediterranean locomotives. Since 1890 large numbers of such engines have been built or ordered by French railroad companies, and their aggregate number will soon exceed 2,000.

Mallet four-cylinder engines are used on meter-gage lines. These are supported on two separate groups of coupled axles: One group, driven by the high-pressure cylinders, is connected to the locomotive frame in the ordinary way; the other group, driven by the low-pressure cylinders, forms a movable truck, so as to give great flexibility to the engine.

The majority of the compound engines belong to two classes, which may be considered as standards in France: The express locomotive, with four large coupled wheels, of 2 m. (6 ft. 6¾ ins.) diameter or a little more, and the six-coupled locomotive, with diameters of from 1.600 m. to 1.750 m. (5 ft. 2 15-16 ins. to 5 ft. 8⅞ ins.), both being fitted with a truck in front. The six-coupled locomotives are equally fit for goods and for ordinary passenger trains.

The new "Atlantic" (Nos. 3,001-3,008), recently built for the Paris-Orleans by the Société Alsacienne de Constructions Mecaniques, is of special interest as being the most powerful express locomotive yet made for the French lines. The adhesive weight is 36 tonnes (18 tonnes per axle), and it is expected that this weight will be increased to 40 tonnes. Such a change is easy in locomotives of this type.

The following figures, extracted from the dynamometer car records and indicator cards taken during numerous runs of these engines with heavy express trains, give a fair idea of their power:

A length of 13 km. (8 miles) was traversed in 419 seconds, being at a rate of 112 km. an hour (70 miles). The cut-off was at 53 and 65 per cent. respectively, in the high and low-pressure cylinders. The mean drawbar pull, behind the tender, was 2,350 kg. (5,180 lbs.), from which results an average effective horse-power of 972; the mean indicated horse-power was 1,830. The maximum indicated horse-power recorded on these engines was 1,900. (The unit of horse-power used here is 75 kg. × 1 m. in a second, while the English unit is slightly greater.)

On the Nord, "Atlantic" locomotives, with somewhat smaller dimensions, maintain a very fine express service. Average speeds, from end to end, of 90 to 100 km. an hour (56 to 62 miles), are obtained with trains weighing (exclusive of locomotive and tender) 250 to 300 tons. The profile of the lines is generally easy, with somewhat prolonged inclines of 5 mm. per m. (1 in 200), and, in a few places, of 8 mm. per m. (1 in 125). Some of these trains run in connection with boats from England, and, in many instances of bad weather, time lost by the boat has been made up by the train, although the schedule is calculated with a pretty fair speed.

The advantages of the four-cylinder compound system, as resulting from a prolonged practice in France, may be summed up as follows: Economy of coal resulting from the compound system in itself, or increase of power with the same consumption of coal; good utilization of steam at very high pressure, with the simple or piston valve and the old gears; good balance of pistons and other pieces with reciprocating motion; counterweights applied only for revolving parts, thus doing away with vertical variations of pressure and pounding action on rails; ample bearing surfaces for all parts of mechanism, owing to the use of four cylinders with four separate gears and suppression of all undue strains.

It must be added that these compounds possess great elasticity in working, and are as well fitted for moderate as for high speeds, for light or for heavy trains. They remain economical within a wide range of power. In the Paris-Orleans experiments an average steam consumption of 10.5 kg. (23 lbs.) per horse-power in an hour (the power being calculated from the action exerted by the driving wheels on the rail, to compare precisely with what is called the effective power of a stationary engine) has been measured with trains of heavy and also moderate weight.

As regards details of construction, the nearly exclusive use of Serve or ribbed tubes in all new constructions is well worth mentioning. Experiments have proved that the efficiency of a given surface of Serve tubes, taking into account the whole metallic area in contact with hot gases, was about the same as with the same surface of plain tubes; and in practice these tubes have been found durable and free from leakage. They must be kept free from ashes and soot by frequent cleaning with a steam jet and, when necessary, with scrapers.

For valve gears the Walschaerts system has been adopted in many of the French four-cylinder compounds, as well as for ordinary locomotives. This system is quite convenient when the valve is placed above or under the cylinder, and there is a distinct advantage in the use of one eccentric instead of two, for inside as well as for outside cylinders. The whole mechanism is simple and easily kept in order. The distribution of steam effected by the Walschaerts system is particularly good, and quite uniform on both sides of the piston at different points of cut off.

Piston valves are used in some of the latest designs. After the experience of the Eastern, they are preferable to flat valves, chiefly as giving larger ports and so reducing wire-drawing and compression of steam. An economy of coal, as high as 10 per cent., has resulted from their use in some cases.

From prolonged experience and from the unanimity of opinion of all having experience with these engines, it may be taken for granted that the four-cylinder compound system possesses marked advantages, at least under the conditions of service prevailing on main French lines. Thanks to their use, French railroads have been enabled to increase largely the weight and the speed of their trains, for goods as well as for passenger service, without any large increase of coal consumption per kilometer run. In fact, it is rather under-estimating the merits of the compounds to say that by their use the weight of trains is increased by one-third with the same cost of fuel over what it was with the best simple engines used before; or, if not the weight, speed is increased, and in many cases both weight and speed.

In other words, the compounds would take a traffic equal to four, against a traffic equal to three, the number of engines and the expenses for fuel and wages remaining the same. The initial cost of the compounds is higher, the expenses for repairs may be somewhat greater, but the increase of traffic is such that the economy is obvious. As regards the cost of repairs, there is still some doubt as to their exact amount, as a very large proportion of the compounds have been running for a few years only, but it must be remarked that the increase of expenses will very likely be due to the boilers working at a high pressure, and it seems that the same pressures would be necessary for simple engines, if they were to compete with compounds.

To this must be added, especially for passenger service, the advantages of greater speed, of more punctuality, and of dispensing in many cases with pilot engines or with supplementary trains. In a mere practical point of view, the French administrations feel satisfied with the great extension they gave to the four-cylinder compound system, from which resulted economy as well as a large improvement in their services.

A complete solution of the problem would require a proof that the same results might not be obtained in some other way. Available data are not sufficient to give such a proof in an incontestable manner; still, it seems difficult to build an ordinary locomotive quite equal in every respect to the latest compounds.

It is clear that simple two-cylinder engines might be made with the same large boiler, and work with the same high-pressure, but it is nearly as clear that, with the ordinary valve gear of the locomotive, steam at such a high pressure cannot be utilized as well as by compounding; there is little doubt that the simple locomotive would require more steam for the same work or give less work for the same quantity of steam. In addition, there is a real difficulty in making all the parts of the simple engine strong enough to stand without undue wear the greatest stresses resulting from the increased pressure on large pistons, although this difficulty may be overcome.

An opinion which seems to prevail is that compound locomotives may be economical during long runs, but that their advantage is lost when they stop and start frequently, owing to the direct admission of steam to the low-pressure cylinders at starting. This opinion is rather too dogmatic, and the question requires some consideration. In many cases, with four-cylinder compounds, the tractive power necessary for starting from rest is obtained without this direct admission, or steam is admitted in that way only for the very first revolution of wheels. The engine is then worked compound, but in full gear for all cylinders. Of course, steam is not so well utilized as with a proper degree of expansion in each cylinder, but, even in that case, the compound compares favorably with a simple locomotive working in full gear.

In conclusion, opinions expressed by men placed at the head of locomotive departments of French railroads will be found of interest. Among others, M. Baudry, locomotive superintendent of the Paris, Lyons & Mediterranean, ended a communication to the Société des Ingenieurs Civils as follows:

"Some people may be of opinion that the importance of the coal saving due to compound locomotives is small, and even vanishes when the prices of coal are very low. That is a mistake, as the saving of coal means really an increased power of the locomotive. In fact, there is no saving of coal for a certain work performed, but there is more work for the same coal consumption; thence result other important savings; less locomotives, less drivers, less firemen, less trains are necessary for a given traffic. These aggregate savings, which do not depend upon the price of coal, greatly exceed, in the majority of cases, the saving of coal proper. If the weight of trains is not increased, then an acceleration in speed is possible, and in that way the construction of more economical locomotives has resulted, during the last few years, in an increase of speed on all French lines."

M. Salomon, locomotive superintendent of the Eastern, writes that:

"Compared to the ordinary locomotive, the compound locomotive has the important advantage of a coal economy, which varies with the nature of the service, but which is, on an average, from 10 to 15 per cent. With the use of four cylinders the symmetry of the engine is preserved, inertia forces are in better equilibrium, the turning force is more uniform, the total work is divided between two axles, and stresses are more evenly distributed on the frame. As a consequence, the mileages between two heavy repairs in the shops has been increased by 50 per cent.

"In my opinion, the use of these locomotives marks an important improvement, which has not been accompanied by any trouble in service; the only objections which have often been made to the use of compound locomotives are want of elasticity in their power, and excessive compression of steam at high speed. As regards the first objection, the use of independent gears for the high and for the low-pressure cylinders allows a satisfactory distribution of steam under very different rates of weight and speed. The second objection vanishes with large clearances and sufficient area of steam passages on the low-pressure cylinders. In this respect piston valves will be quite suitable if they remain sufficiently tight."

CAR WHEEL LATHE.

This machine, specially designed for turning steel tired car wheels by the Pond Works of the Niles-Bement-Pond Company, is able to take complete advantage of the use of the high speed tool steels, due to its smooth, powerful drive and the rigid manner in which the wheels are gripped and this, in addition to the improved facilities provided for placing the wheels in the lathe and removing them, has enabled it to very greatly increase the output over that produced by old methods.

FIG. 1—REAR VIEW OF CAR WHEEL LATHE.—NILES-BEMENT-POND COMPANY.

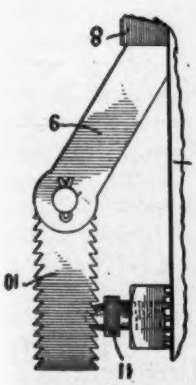


FIG. 2—"SURE GRIP" DRIVER.

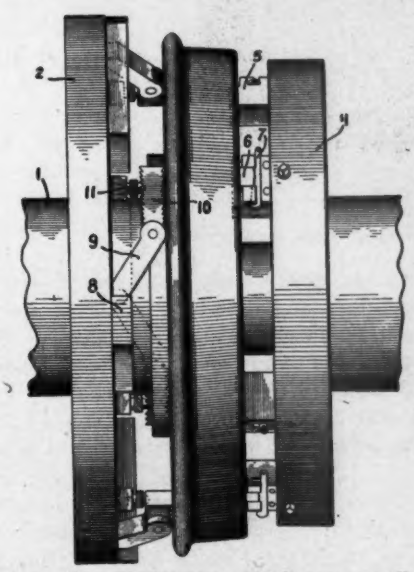


FIG. 3—APPLICATION OF "SURE GRIP" DRIVER.

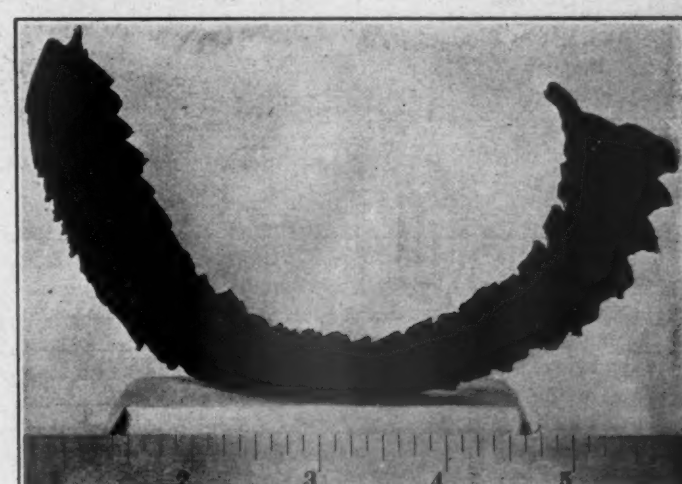


FIG. 4—CHIP TAKEN ON 36-INCH MIDVALE TIRE.

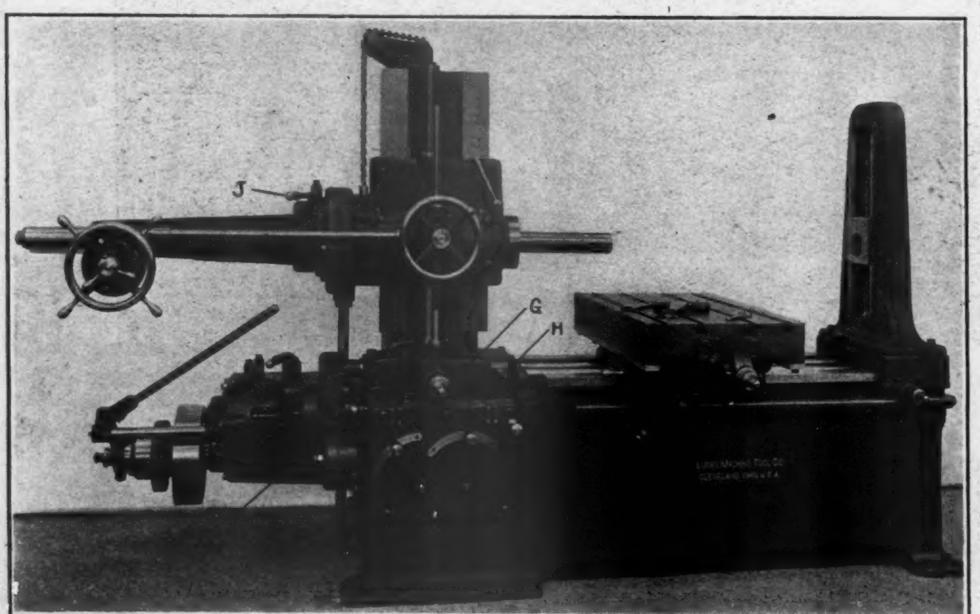
Fig. 1 is a rear view of the machine and shows a pair of wheels about to be rolled out of the lathe. The large gear from which the section has been removed to allow the wheels to be rolled out, is driven by a worm which runs in oil and which gives a very smooth and powerful motion to the driving plates. In placing wheels in the lathe they are rolled into the position shown, bushings are put on the journals and the tailstocks are brought up. The "Sure Grip" drivers, shown in detail in Fig. 2, are then adjusted as shown in Fig. 3. The chucking jaws in the face plate hold the tires rigidly and by screwing up the set screws of the "Sure Grip" drivers the tires are firmly wedged between the driving plates and the chuck jaws so that the full power of the machine can be utilized. Plain chuck jaws are in most cases sufficient and parts 5, 6 and 7, shown in Fig. 3, which are used to prevent the tire from being crowded off, can be omitted. After the wheels are in place the section of the large gear wheel can easily be slipped into position and is held by a key. The two large bolts, one of which is shown to the left of the section of the gear, are put in place and the nuts tightened. The lathes are set level with the floor so that the wheels can easily be rolled into place and a pit is provided at the front of the machine for the con-

venience of the operator. With the wheels convenient to the lathe, the actual time of taking out one pair and putting in another should not consume more than 8 to 12 minutes.

This lathe, with an experienced operator and good facilities for getting the wheels to and from it, can turn out from 5 to 7 pairs of wheels per day of 10 hours, or an average of 36 pairs per week. Practical experience has demonstrated that the output is greatest when the feed and cut are a maximum rather than when a high cutting speed is used. Fig. 4 shows a chip taken on a pair of 36-in. Midvale tires, the tool being of Midvale special steel, 3 x 1¼ ins. in section, depth of cut 11-16 in., feed 7-16 in., cutting speed 9 ft. per minute. A tool of self-hardening steel of the above size is large enough to prevent springing or breaking and the large cross section has the advantage of rapidly carrying away the heat generated at the cutting edge.

NEW DESIGN OF HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

This machine, illustrated in the halftone, is of radically different design from the conventional "knee type" of horizontal boring, drilling and milling machine and is constructed with a view to increasing its capacity and usefulness by adapting it for a wider range of work than is usually handled by such machines. The vertical adjustment is made by raising or lowering the spindle head instead of the platen, which on the ordinary type of machine is difficult of adjustment if carrying a heavy load. This allows the use of a vertical power feed for milling purposes which is impossible on the old construction where the platen after it is adjusted must be clamped to the yoke in order to obtain sufficient stiffness. The elevating screws for raising and lowering the spindle head and the outer support for the boring bar are connected by planed bevel gears to the same driving shaft and are therefore automatically kept in alignment. The spindle is of crucible steel and has a long bearing in the sleeve. The front of the sleeve forms a face plate to which the facing head or face milling cutters or other large tools may be attached. The hand wheel on the front of the head gives a slow motion to the spindle and the one to the left a fast motion.



HORIZONTAL BORING, DRILLING AND MILLING MACHINE.—LUCAS MACHINE TOOL COMPANY.

The platen is provided with a power cross feed in order to make the machine complete for milling purposes and thus increase its usefulness and in many cases save the rehandling and resetting of the work. The cross motion of the platen is great enough so that work can often be adjusted on one end of it while the machine is boring a piece on the other end. The yoke is adjusted endwise by turning with a wrench the shaft E, which has on its opposite end a worm hobbed to fit the stationary screw, the screw and worm acting as a rack and pinion. Where it is desired to do work on pieces longer than the nominal capacity of the machine, the outer support for the boring bar can be removed entirely by loosening the four T bolts which hold it to its base. Lateral adjustment of the platen is obtained by turning the shaft D.

The feed motion is taken from the main driving shaft which runs at a much higher speed than the spindle and makes it possible to get a coarse feed without gearing up; the finer feeds being obtained by gearing down. This makes the feeds exceptionally powerful. It also furnishes two series of feeds, one when the spindle back gears are out and one when they are in, the coarser ones being obtained when the spindle back gears are in. The feeds vary from .004 to .283 in. per revolution of the spindle and are controlled by the levers A and B, which furnish 9 changes or 18 different feeds with the spindle back gears in and out. The lever C reverses all feeds. The lever J operates sliding gears which connect the vertical driving shaft to the spindle and are known as the back gears.

G furnishes a vertical hand adjustment for the spindle head. H operates two clutches in the feed box; when it is in one position the feed for the spindle is engaged and that for the table is disengaged; when in the other the feed for the table is engaged and that for the spindle disengaged. The lever F operates the power vertical quick motion for the spindle head up and down.

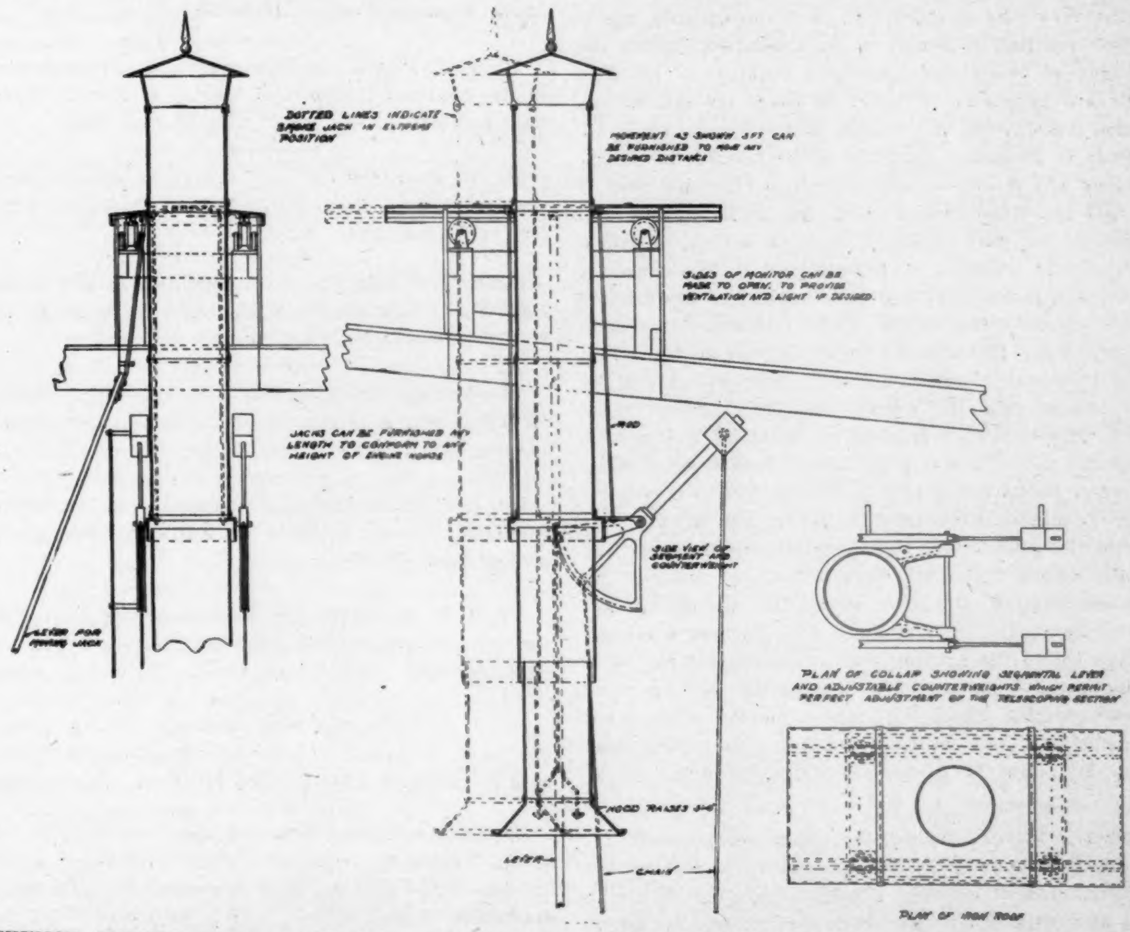
The gear box is bolted on the end of the bed and contains steel cone gears which are manipulated by the two levers shown on top of the box and furnish 6 changes of speed which in combination with the back gears on the spindle head give 12 changes of spindle speed in correct geometrical progression. The driving pulley can be engaged or disengaged by means of a friction clutch which is operated by the long handle placed convenient to the operator. A direct connected motor drive can be applied if desired.

Adjustments of the spindle head outer boring bar support and platen are made by precision screws which are provided with dials graduated to 1-1,000 of an inch, thus allowing holes to be bored and surfaces to be milled an exact distance apart, making it possible to produce interchangeable work without the use of jigs.

The machine is self-contained and the bed, which is of a deep box construction, has 3 feet, is stiff enough to set on any good floor and does not require a special foundation. This machine is made by the Lucas Machine Tool Company of Cleveland, and is known as No. 1 Precision boring, drilling and milling machine. They also make a No. 2 machine of the same general design, but larger in size and better adapted to the class of work it would be required to handle in a railroad shop.

We expect to build a shop or shed with two tracks long enough to hold twenty steel cars each. Before they are taken in on track No. 1 we will remove the scale from the inside with a pneumatic hammer and the paint and rust from the outside with a sand blast. Then as they are run in we propose to paint them with a movable spraying machine suspended above the cars on a track running the length of the shop, using a double hose, so that both sides of the cars can be painted at the same time. After giving them two coats we will put them on track No. 2 for drying and stenciling.—*B. F. Wynn, Master Car and Locomotive Painters' Association.*

ROUNDHOUSE EQUIPPED WITH OVERHEAD CRANES AND MOVABLE TELESCOPIC SMOKE JACKS.



THE DICKINSON MOVABLE SMOKE JACK—TOGETHER WITH THE SMALL SECTION OF ROOF IT HAS A MOVEMENT OF 3 FEET TO ACCOMMODATE ITSELF TO POSITION OF LOCOMOTIVE—ALL PARTS OF CAST-IRON.

ROUNDHOUSE CRANES AND SMOKE JACKS.

Progress during the past five years in the use of heavy locomotives and heavier trains has entirely changed the status of the roundhouse and given to it an importance which it never had before. Instead of merely providing housing for engines, the roundhouse has become a shop for running repairs, and a very important shop, because the satisfactory operation of locomotives is directly dependent upon its efficiency. The roundhouse is to-day, in addition to its other functions, a shop for emergency repairs of a most important character, because terminal delays have become a great item of expense when locomotives are in such great demand as at the present time. The weight of locomotive parts is now so great as to cause

not only difficulty and expense but hardship in the roundhouse, where the work is handled in the old way without suitable facilities. A light, overhead crane, which is always ready for use, is one of the best factors for economy which is available for a roundhouse. Lifting by cranes as contrasted with lifting by manual labor is everywhere considered one of the most economical processes for the saving of labor. It has been considered impossible to equip roundhouses with cranes in such a way as to avoid interference with the smoke jacks, because, most of the lifting being at or near the front ends of the engines, the cranes must necessarily be able to pass the jacks. A simple and effective way out of this difficulty is illustrated in the accompanying engravings, showing the construction developed by Mr. Paul Dickinson, of Chicago. The difficulty is met by the use of multi-telescoping jacks, which telescope to an extent permitting them to be raised entirely clear of the crane. The photograph engraving shows a combination of a crane and telescoping jacks arranged in this way. Interlocking appliances prevent contact of the crane with the jacks before the latter are raised out of the way. The crane is locked when the jacks are down, and the jacks are locked when the crane is over the stack. The convenience of this arrangement and the method of operating the jacks and crane from the roundhouse floor are indicated in the engravings.

Last winter developed a weakness in roundhouses which has never before been fully appreciated. Heavy traffic, combined with unusually severe weather, found roundhouses woefully unequal to the demands made upon them, chiefly because a large amount of repair work was required to be done in an atmosphere of steam, gas and smoke. Good work cannot be done quickly under such conditions, and the trouble became serious in the very cold weather. In fact, the greatest necessity for good ventilation comes in cold weather, when the largest amount of roundhouse work is required. Suitable smoke jacks are necessary in order to carry off the smoke. Mr. Dickinson has devoted much time and study to this problem. He finds it necessary that the jacks should fit tightly over the stacks of the locomotives, and it is conceded that if the smoke and gases are carried from the stacks directly out of doors, the largest part of the problem is solved. Because of the difficulty in stopping a locomotive, or "spotting" it exactly under the jacks, and also because of the desirability of being able to move the engine slightly, forward or backward, it is necessary to build the jacks to provide for movement and adjustment along the track, or a great deal of smoke will escape into the house, especially when forced draft is used, and it always is used in firing up and getting ready for going out. This is particularly troublesome when the engine must be moved a few inches to work on rods or pistons. Mr. Dickinson provides for this by moving the jack to conform to the position of the locomotive and insure the passage of the smoke without getting it into the house. The method of construction and the levers for moving it are shown in the engraving. Experiments with various materials for jacks have led to the opinion that cast-iron is most satisfactory. The improvements shown are considered important in roundhouse practice, which will have a marked effect upon roundhouse efficiency and service. Further information may be had from Mr. Paul Dickinson, Security Building, Chicago, Ill.

Will the electric railway replace the steam locomotive?

Perhaps the best answer is that its future is not in the wholesale destruction of existing great systems. It is in the development of a field of its own, with recognized limitations but of vast possibilities. It will fill that field to the practical exclusion of all other methods of transmitting energy; it will operate all street railway systems, and elevated and underground roads; it will prove a valuable auxiliary to trunk systems; but it has not yet sounded the death-knell of the locomotive any more than the dynamo has that of the stationary steam engine. Each has its own legitimate field which will play its proper part in the needs of all civilization.—*Frank J. Sprague, International Electrical Congress.*

PERSONALS.

Mr. H. H. Warner has resigned as master mechanic of the Northern Pacific at Seattle, Washington.

Mr. S. King has resigned as master car builder of the Intercolonial Railway, to become assistant master car builder of the Canadian Pacific.

Mr. Thomas M. Feeley has been appointed master mechanic of the Iowa Central Railway, with headquarters at Marshalltown, Ia., to succeed Mr. W. O. Johnson.

Mr. W. L. Larry has been appointed master mechanic of the New York, New Haven & Hartford Railroad at Taunton, Mass., to succeed Mr. A. W. Twombly.

Mr. A. W. Sullivan has resigned as assistant second vice-president of the Illinois Central to become general manager of the Missouri Pacific, with headquarters at St. Louis, Mo.

Mr. A H. Gairns has been appointed general foreman of the San Bernardino shops of the Atchison, Topeka & Santa Fe Railway at San Bernardino, Cal.

Mr. G. H. Bussing has been promoted from the position of assistant superintendent of motive power to that of superintendent of motive power of the Evansville & Terre Haute.

Mr. C. T. Howe has been appointed master mechanic of the New York, New Haven & Hartford Railroad at South Boston, Mass., to succeed Mr. S. P. Willis.

Mr. P. F. Flavin has been appointed acting master mechanic of the National Railroad of Mexico at Laredo, Texas. He has been foreman of the boiler shop at that place.

Mr. W. F. Girten has been appointed general foreman of car repairs of the Central Railroad of New Jersey, with headquarters at Elizabethport, N. J.

Mr. C. T. Sheldon has been appointed master mechanic of the New York, New Haven & Hartford Railroad at Valley Falls, R. I., to succeed Mr. L. M. Butler.

Mr. William Hassman has been appointed master mechanic of the Peoria & Pekin Union Railroad, with headquarters at Peoria, Ill.

Mr. I. C. Hicks has been appointed master mechanic of the Atchison, Topeka & Sante Fe Railway, with headquarters at Albuquerque, N. Mex.

Mr. R. M. Boldridge has been appointed master mechanic of the Mississippi Central Railroad, with headquarters at Hattiesburg, Miss., to succeed Mr. C. H. Welch, resigned.

Mr. J. A. Edson has been appointed general manager of the Chicago, Cincinnati & Louisville Railroad, with headquarters at Cincinnati, Ohio, to succeed Mr. C. G. Waldo, resigned.

Mr. Charles Gaspar has been appointed mechanical engineer of the Wisconsin Central Railroad, with headquarters at Fond du Lac, Wis. For the past two years his title has been chief draftsman.

Mr. C. F. Richardson has been appointed general road foreman of equipment of the St. Louis & San Francisco, with headquarters at St. Louis, Mo. He has been road foreman of engines of the Baltimore & Ohio.

Mr. Frank Hedley has been appointed general manager of the Interboro Rapid Transit Company of New York, to relieve Mr. E. P. Bryan, who has been vice-president and general manager and who retains the position of vice-president.

Mr. J. A. Hill has been appointed master mechanic of the Lake Erie & Western Railroad, with headquarters at Lima, Ohio, to succeed Mr. William White.

Mr. Clement F. Street has severed his connection with the Wellman-Seaver-Morgan Engineering Company to accept the position of commercial engineer of the Westinghouse Electric & Manufacturing Company, with headquarters in Pittsburg.

Mr. R. Atkinson has resigned as master mechanic of the Philadelphia & Reading at Reading, Pa.

Mr. William White has resigned as master mechanic of the Lake Erie & Western at Lima, Ohio, to enter the service of the Chicago Pneumatic Tool Company.

Mr. S. J. Campbell has been appointed master mechanic of the Chicago, & Alton Railroad, with headquarters at Slater, Mo., to succeed Mr. F. P. Roesch, resigned.

Mr. A. L. Rossetter has been appointed master mechanic of the Chicago, Peoria & St. Louis Railroad of Illinois, with headquarters at Springfield, Ill.

Mr. Charles Wilson has been appointed master mechanic of the Lehigh Valley at Wilkesbarre, Pa., to succeed Mr. F. F. Gaines, resigned.

Mr. John Howard has been appointed superintendent of motive power of the New York Central & Hudson River Railroad in addition to his duties as superintendent of motive power of the Boston & Albany. His headquarters will be at the Grand Central Station, New York.

Mr. F. W. Brazier has been appointed superintendent of rolling stock of the New York Central & Hudson River Railroad. His title for the past six years has been assistant superintendent of rolling stock. His jurisdiction is extended over the Boston & Albany, in addition to the New York Central.

Mr. LeGrand Parish has been appointed assistant superintendent of motive power of the Lake Shore & Michigan Southern Railway, with office in Cleveland. Those who know Mr. Parish and his work will be pleased by his advancement to a position of greater responsibility. He entered the service of the Lake Shore as a clerk in the car department, and his superiors being impressed with his administrative ability, he was soon made foreman of car repairs, serving in that capacity for several years and at two important repair points. About six years ago he was appointed master car builder at Englewood, Ill., where he had charge of the maintenance of car equipment on the western portion of the road, and this position he now leaves to go to Cleveland. He owes his success to thoughtful study of the problems coming before him and to business methods in dealing with them, combined with good judgment of men and unusual ability in managing his subordinates in a way which brings voluntary loyal support from all. This appointment is announced with a conviction that Mr. Parish is only beginning a career of increasing responsibility and recognition.

Mr. Frederick M. Whyte has been appointed general mechanical engineer of the New York Central lines, with headquarters in the Grand Central Station, New York City. He has held the position of mechanical engineer of the New York Central & Hudson River Railroad since August 16, 1899, and is admirably equipped by education and experience for the important work of his new position. Mr. Whyte is 39 years of age, and was graduated from Cornell University in 1889. He entered railroad service in that year, and has been draughtsman in the motive power department of the Lake Shore & Michigan Southern, in the testing department of the Baltimore & Ohio, in the office of the late David L. Barnes in Chicago, was connected with the South Side Elevated Railway and the Northwestern Elevated of that city, and a member of the staff of the *Railroad Gazette* in the same place. In 1897 he was appointed mechanical engineer of the Chicago & Northwestern Railway, and resigned in 1899 to take the position on the New York Central from which he is now promoted. Mr. Whyte's present appointment is an exceedingly important one, and is the only one carrying the title of general mechanical engineer of a system of allied lines. It is a step in the direction of unification of the engineering problems of a system of roads which brings great possibilities of advantage from a standpoint of the business interests of the roads as affected by the mechanical department. Mr. Whyte and the New York Central lines are to be congratulated upon this fitting appointment.

ELECTRIC TRACTION ON THE ERIE.—This road contemplates the application of electric traction to 51 miles of its New Jersey suburban district, with a central power station at Paterson.

COMPRESSED AIR METERS.—At the recent Holyoke convention of the New England Waterworks Association a new meter for measuring compressed air was exhibited. A device of this kind, if accurate, would be a valuable aid to the economical use of compressed air in railroad shops.

The adoption of electricity on any trunk line service will be determined by the hard and fast rule of financial necessity. It is my belief that some of the largest expenditures, and those most fruitful of return to those who own the steam railroads of the country to-day, will be in the purchase and control of the competing electric railways which, having in the past acquired franchises of undoubted value, have built up a business which they can hold and which will increase, and many a steam railway will be better off financially and bring bigger returns if it gathers in these franchises and systems and takes to its lines an advantage it will be difficult to duplicate in the future.—*F. J. Sprague, International Electrical Congress.*

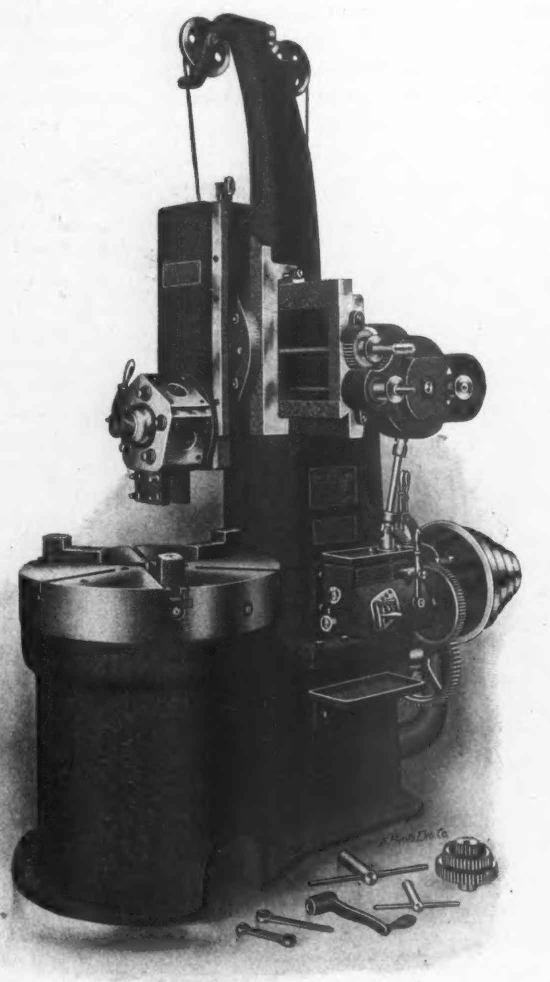
HIGH-PRESSURE PACKING.—A new packing for high-pressure service has been placed on the market by the New Jersey Asbestos Company, of Camden, N. J. It is moulded to shape in steel dies under hydraulic pressure, making it nearly as solid as if of metal, and yet it remains flexible. The rings are made of the same material as the well-known "Gladiator" asbestos metallic packing. They do not burn out or blow out of the stuffing boxes, and a number of prominent railroads are using them on locomotives, where satisfactory packing is specially appreciated. Information concerning these packing rings may be obtained from the manufacturers.

GOLD MEDAL FOR RAIL JOINTS.—The Jury of Awards of the Louisiana Purchase Exposition has awarded the gold medal for rail fastenings to the Continuous Rail Joint Company of America, for their display made in the Transportation Building, of their rail-joint products. The exhibit shows various types of rail joints produced by patented machinery controlled by the company in this country. Further acknowledgment of the merits of the continuous rail joint is shown in the fact that over 20,000 miles of railroad track has been equipped within the past ten years. The company owns and operates the Albany Iron & Steel Works, at Troy, N. Y. This company is now bringing out a new type of insulated rail joint, and also an electric bonding joint to be placed upon the market. The development of the business has made it necessary to organize a company in Canada for the exclusive use of Canadian patents originally owned by them, and another corporation in London, England. This appliance has already been introduced in many foreign countries. The general offices of the company are at Newark, N. J.

30-INCH BORING AND TURNING MILL.

The boring and turning mill illustrated in the photograph is equipped with a swivel turret head, and presents great possibilities as a time and labor saver on certain classes of work. It swings 32 ins. in diameter and 15½ ins. under the cross rail, and can be furnished with either a three-jaw independent and universal chuck combined, as shown, 30 ins. in diameter or with a plain table, with or without jaws. The face plate is bolted to a large driving gear, which has an outer bearing with an automatic oiling device arranged in the bed to keep the bearing well lubricated. The face plate has eight changes of speed, from 18 to 73 r. p. m., without back gears, and from 2.28 to 9.3 r. p. m. with back gears. The centre spindle is 7 ins. in diameter, 18 ins. long, and is made with an angular bearing to receive side strains, with check nuts on the under side of the spindle to prevent any lifting tendency.

The turret has five sides, 10 ins. across flats, and has five 2 3-16-in. holes. The turret slide has a traverse of 16 ins., and in the swivel head can be set over at any angle up to 30 degrees, and will face 30 ins. in diameter. The mill has a



30-INCH BORING AND TURNING MILL.—BAUSH MACHINE TOOL COMPANY.

Hendey-Norton change gear device on its upright for feeding and thread cutting. Twenty vertical feeds are provided from .0125 to .1666 in. per revolution of the table, and twenty horizontal feeds are provided from .015 to .211 in. per revolution. The mill is driven by a cone of large diameter, taking a 3-in. belt, and is so arranged that a motor drive can be applied at any time. The back gears can be changed by means of a lever without the use of a lock nut. The machine weighs 5,900 lbs., and is self-contained, and therefore does not require an expensive foundation. It is made by the Baush Machine Tool Company, Springfield, Mass.

HIGHEST DEVELOPMENT OF AIR BRAKES.

The High Speed Brake.

This country is impressed as it never has been before with the necessity for safeguarding lives and property in transportation and its railroads are earnestly seeking means for meeting the problem of safety of trains. Among these is increased braking capacity, because the limiting conditions of safe speeds lies in the ability to stop quickly. Much is said about phenomenally high speeds of 100 miles per hour and over, but these will not be attained in regular service unless brake practice develops with the increased speeds.

For 40 years of the early history of railroad progress the brake problem was not attacked. Up to 1864 no real improvement in braking was attempted. Since that year progress has been rapid, especially since the first use of the compressed air by Mr. Westinghouse, and now we have in the "High Speed Brake" the greatest development in this field and one which means more for the safety of fast trains than any other appliance now available.

At the St. Louis Exposition this brake is exhibited by the Westinghouse Air Brake Company and the usual applications of apparatus with which all railroad men are familiar have given place to this apparatus which was designed to meet the greatest present need.

The improved brake requires little apparatus in addition to that of the quick action brake, and no change in the mechanism of the latter; but a train-line and auxiliary reservoir pressure of 110 lbs. is employed instead of 70 lbs., the pressure generally used in connection with the quick-action brake. The high speed brake consists of the quick-action air brake apparatus as ordinarily applied to a passenger car, to which is added an automatic reducing valve that is attached to the body of the car adjacent to the air cylinder, to which it is connected by means of a pipe. This reducing valve is so constructed that it remains inert in all service applications of the brake unless at any time the brake cylinder pressure becomes greater than 60 lbs., in which event the valve operates to discharge promptly from the brake cylinder as much air as necessary to restrict the cylinder pressure to that intended. In an emergency application of the brakes the violent admission of a large volume of air to the brake cylinder raises the pressure more rapidly than it can be discharged through the port of the reducing valve, and the air is discharged from the brake cylinder in such a manner that it does not become reduced to 60 lbs. until the speed of the train has been very materially checked. On emergency application, the high train line and auxiliary pressures fill the brake cylinders almost instantly with air at about 85 lbs. pressure, thereby giving a pressure of the brake shoes upon the wheels about 40 per cent. greater than that realized by the use of the quick-action brake alone. The air pressure immediately begins to escape from each brake cylinder through the automatic reducing valve, continuing to do so until the cylinder pressure is reduced to 60 lbs., which is thereafter maintained until the brakes are released by the engineer.

On account of the high pressure carried with this brake, a full service application of the brake will leave the pressure in the auxiliary reservoir at nearly 100 lbs.; in fact, 3 full service applications can be made without recharging the auxiliary reservoirs, and there will still remain sufficient air pressure for an emergency stop equal to that of ordinary practice. These advantages, coupled with such a restricted brake cylinder pressure for all service applications of the brake that wheel sliding is avoided, require no further comments to insure recognition of their importance in materially advancing the art of train stopping.

The high speed equipment for a locomotive requires but few parts in addition to the quick-action apparatus and the simple movement of 1 or 2 cock handles to convert the brakes from quick action to high speed, or vice versa, thus making entirely practical the operation of either type without delay or inconvenience. That the brake, with which over 24,500 locomotives

and passenger cars have been equipped, has proven its utility as a positive and material advancement in air brake practice must be patent to all who visit the exhibit and familiarize themselves with its possibilities to accomplish results hitherto unattainable, and that its merits and value are rapidly becoming recognized by railways is apparent from the large number of locomotives and cars in daily service provided with the apparatus. To the layman the term "high speed" is to some extent a misnomer, for while the impression is conveyed that the brake is intended to be used only on trains scheduled at high continuous speeds, its meritorious features can be utilized to distinct advantage on all trains operating on a more moderate schedule but frequently attaining speeds such as that for which the high speed brake was primarily intended. The practicable solution of the important question of train control has been a prime factor in the establishment of fast passenger schedules, and the whole exhibit is an interesting example of the Westinghouse Air Brake Company's policy of harmonizing all of its improvements with its equipment already in service by simple and effective attachments to former standards.

In describing the "Schenectady Superheater Locomotive" on page 339 of the September number, savings of 33 per cent. were mentioned as having been effected by a superheater on the Canadian Pacific Railway. This record was made with a Schmidt superheater.

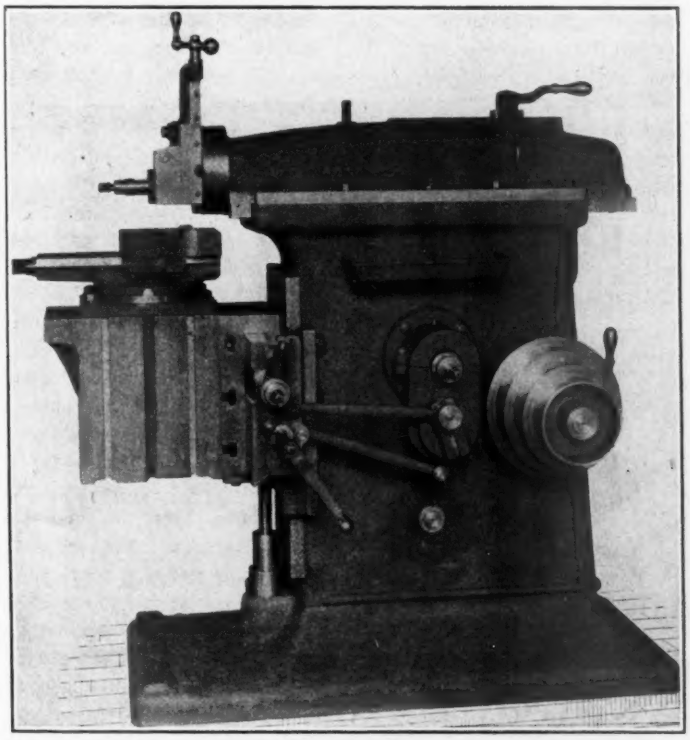


FIG. 1.—16-IN. CRANK SHAPER.—QUEEN CITY MACHINE TOOL COMPANY.

M. C. B. LETTER BALLOT.—The letter ballot, which closed September 25, resulted in the adoption of all the recommendations made at the convention of last June except three. These concerned the distance between the centre of bolsters and the base of the sill, the height and width of cars on high trucks and the lettering on end fascia boards.

LOCOMOTIVE BOILER STEEL AND TUBES.—The result of the letter ballot by the Master Mechanics' Association on the recommendations offered at the convention of last June is announced by Secretary Taylor to be in the affirmative with respect to boiler steel, firebox steel and boiler tubes of steel and iron.

A POWERFUL CRANK SHAPER.

A 16-in. crank shaper designed for heavy work, and with a view to durability, is shown in Figs. 1 and 2. In addition to the substantial design of the various parts, the details of the rocker arm construction are of special interest. The rocker arm is connected to the ram by a link, which allows a more direct pull than does the ordinary design of crank shaper, and gives a very even cutting speed. Wear of the crank shoe can be compensated for by adjusting the screws shown in Fig. 2.

A back gear ratio of 20 to 1 is provided, change from one run of gearing to the other being made by a lever, which throws either one of two gears, keyed to a sleeve which slides on the driving shaft, in or out of mesh with gears on the back shaft. The ram has a bearing of 30¼ x 10 ins., and is designed so that the section gradually increases in strength, and is strongest at the point where the leverage is greatest, which is when the cutting tool is at its extreme forward position.

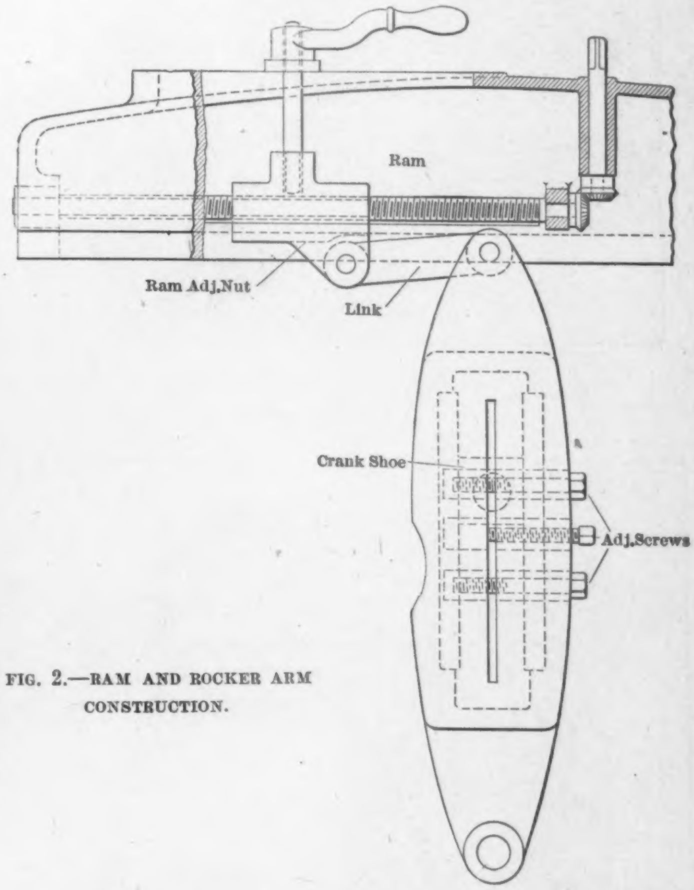


FIG. 2.—RAM AND ROCKER ARM CONSTRUCTION.

Length of stroke and position of the ram can be changed without leaving the work and while the tool is in motion or at rest. The rail is 9 ins. long, and has 1½ ins. top wearing surfaces. The cross traverse is 21 ins., and the screw has a graduated collar. Vertical adjustment is effected by bevel gears, which are protected from dirt and chips, and are provided with ball bearings and operate the telescopic screw.

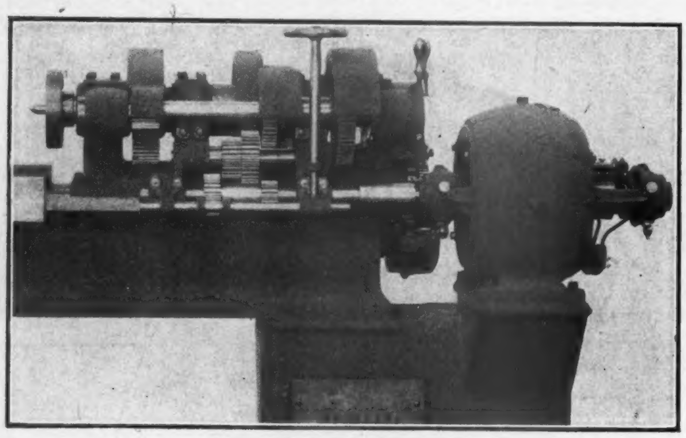
The table, in addition to the T slots on top and sides, has a V for holding shafts and similar work vertically, and can readily be detached from the saddle. An extension provides for a broad clamping surface, utilizing the full length of the stroke. The vise has a base that can be firmly bolted to top or sides of table, and the swivel is held to this base by two steel planer head bolts. The head swivel is held in the same manner; both are graduated, and can be set to any angle, quickly and accurately. A down feed screw to the head is provided with a graduated collar. A large opening under the ram provides for key-seating of shafts or similar work of any length. This shaper is manufactured by the Queen City Machine Tool Company of Cincinnati.

MOTOR DRIVEN LATHE.

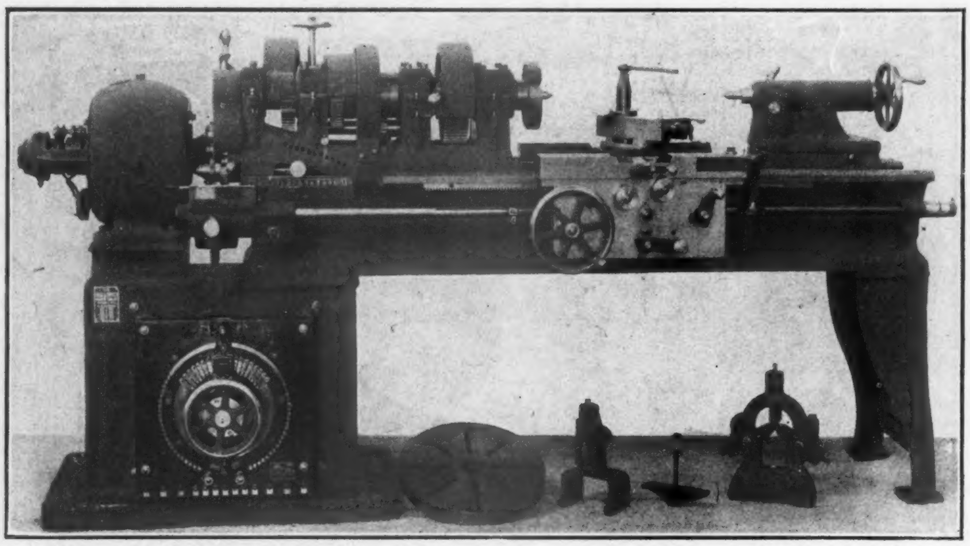
The photographs illustrate a simple and substantial motor application to a Lodge & Shipley 16-in. engine lathe. The lathe is equipped with their improved headstock, which is designed for high speeds and heavy cuts, and is the same as the one described on page 313 of the August issue of this journal, except that it is arranged for the motor drive. The motor is supported as shown.

On an extension of the armature shaft is a sleeve, to which two gears are keyed. The handwheel slides this sleeve along the shaft and throws either gear in mesh with the corresponding gear on the short auxiliary shaft according to the speed desired.

The patent head furnishes three speed changes, which in combination with the two driving shaft speeds furnish 6 mechanical speed changes. This in combination with a Northern 2½ h. p. variable speed motor gives a wide range of speed. As regularly made, the controller is operated from the carriage, and not as shown. If desired, the lathe can be furnished with a pulley suitably supported in place of the motor, so that it can be operated directly from the line shaft with six changes of spindle speed.



REAR VIEW OF LODGE & SHIPLEY LATHE SHOWING MOTOR APPLICATION.



16-INCH MOTOR DRIVEN LATHE.—LODGE & SHIPLEY MACHINE TOOL COMPANY.

DRAINAGE ENGINEER.—The United States Civil Service Commission will hold an examination November 22-23, 1904, for an engineer in connection with the irrigation and drainage investigations in the Office of Experiment Stations, Department of Agriculture, the salary being from $1,500 to $2,000 per annum, according to qualifications. Applicants should apply to the United States Civil Service Commission, Washington, D. C., for application form No. 1,312 and other particulars.

OTTO GAS ENGINE EXHIBIT.

The exhibit of the Otto Gas Engine Works of Philadelphia, Pa., at the St. Louis Exposition occupies the largest space ever devoted to the exhibition of gas and gasoline engines exclusively in this country. The general display at their exhibit is characteristic of the high grade of the engines which they build. There are seventeen engines shown for general and special work, eleven of which are fitted up and running, ranging in sizes from 2 to 140 h.p.

There are several novelties of more than ordinary interest, including a 40-h.p. horizontal single-cylinder engine as shown directly connected to a Diehl generator. The engine is of their special electric light type, which is fitted with their rotary ball governor which regulates the charges taken, or fuel consumed, according to work done; sometimes called "hit and miss" governing. The regulation of this engine gives a variation in voltage not exceeding 2 per cent. with engine carrying anywhere from full load down to but a few lights. The claims made for this engine are, being a single-cylinder type, it requires less attention and is very much simpler in construction than an engine having a multiplication of cylinders in order to get the regulation for electric light purposes. Most users desire an engine which does not require constant attention, which condition this single-cylinder direct-connected type fulfils. Besides, with this method of governing, the idle running gas consumption is less than 18 per cent. of full load consumption, which is decidedly more economical than a so-called throttling governing engine, or one having a multiplication of cylinders, and this adapts itself to many situations where the load during many hours at a time is light. Under these conditions the most economical running is obtained.

The two largest types of engines show latest design for large engine construction, being fitted with their own self starters, the method of starting being to set the engine at the point of ignition and pump a charge into the cylinder with a hand pump. After the cylinder is charged it is cut off by a hand lever, and a somewhat greater pressure is pumped into a vessel which is part of the starter. When sufficient pressure is pumped, the hand lever is opened, allowing the greater pressure in the vessel to come in contact with the engine piston, which slowly turns the engine over when the igniter snaps and a charge is ignited. This gives the flywheel sufficient momentum when the next charge is drawn in by the engine in the regular way. The method of starting insures against failure to start, as it is not dependent upon an air supply stored by the engine when running, and annoyances caused when air is exhausted.

All these engines are fitted with patent electric igniters, having both movable and stationary electrodes, mounted in a phosphor bronze flange, said to be infringed upon by every maker of internal combustion engines using electric igniters.

They also show one of the portable gasoline type of engines used for farming purposes, also a hoisting engine which is very compact and has many points of advantage. The marine type, vertical two-cylinder engine is of the same construction as many of this and larger sizes which they have built for submarine boats. Two types of pumping engines are shown, with vertical and horizontal pumps, direct geared to the engine, making a very compact design. There is also a 10-h.p. engine belted direct to a generator. The space is very brilliantly lighted by arc and incandescent lamps, which are being operated by engines in the exhibit.

The company also exhibit a number of awards, gold and

silver medals, which they have received. Their engines have been exhibited at all the prominent expositions, and they claim the distinction of having over one hundred gold and silver medals, and numerous awards and diplomas, leading in the number of awards made over any other piece of machinery that was ever exhibited.

HIGH SPEED TOOL TESTS AT THE EXPOSITION.

On October 12 a meeting at which 14 of the high-grade steel makers of the world were represented either in person or by proxy, was held in the Palace of Machinery, with Mr. E. S. Kiger as chairman, and rules and regulations governing a steel test to take place on September 10 at Block 9, Machinery Hall, were adopted. On September 10 only three of the makers, including Edgar Allen & Company, Ltd., Hugo Reisinger, maker of the Victoria steel, and the McInnes Steel Company, were prepared to participate in the test. Three other makes were tested under protest. The jury of awards has not yet made known its decision.

The rules adopted to govern the test were as follows: Size of tools to be 1½ ins. x 2¼ ins. by 1 in., to fit Armstrong tool holders. A certain form of William Sellers Company tool to be selected as the tool to be used by each contestant, and all tools to be ground on a William Sellers Company grinder. Each contestant to have his tools forged on the Exposition grounds. The number of tools be limited to two forged tools and two for Armstrong tool holders. The cut to be ¾ in. deep or a 1½ ins. reduction, 3-16 in. feed, at a cutting speed of 100 ft. per minute, to be run as long as the tool will stand up and retain the proper cutting edge, which shall be determined by the judges. For the second tool used, the speeds and feeds to be determined by a majority of the judges.

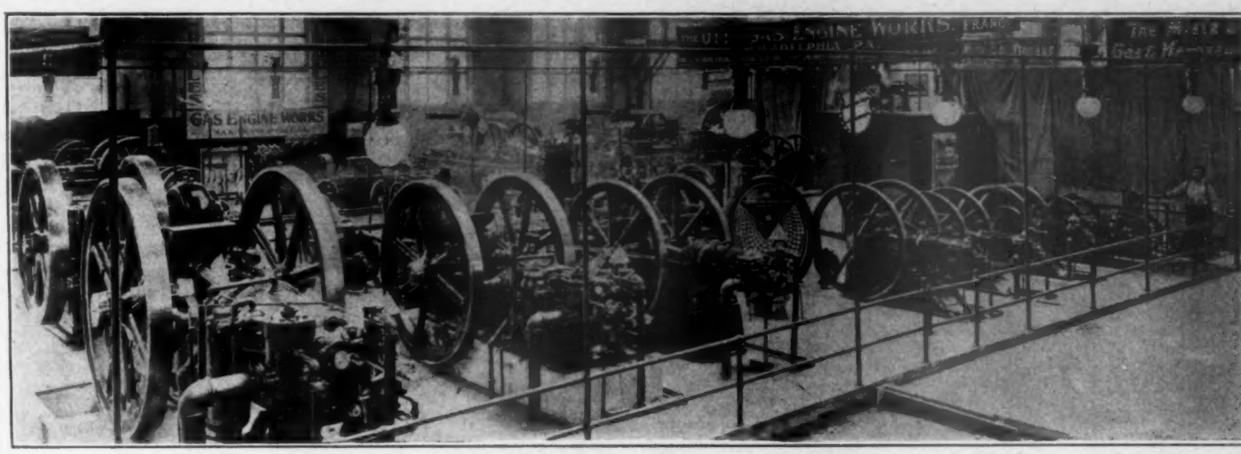
The falling down of tools to be determined when it loses size of cut. If a tool breaks between the cutting point and the tool post it shall determine the life of that particular tool, and if the second tool breaks between the aforesaid points, it shall terminate the test of that particular brand of steel. The various brands of steel offered for test shall be the same as offered on the market regularly for sale. Tools, when forged, tempered and ground, must be turned over to the committee. No preliminary test to be permitted before the official test. A committee of five was appointed, with Mr. Edwin R. Kent as chairman, to take charge of tools before and after tests, examine steel and see to the forging and grinding and other preliminary matters. But one brand of steel to be entered in the contest by any one representative. Tool No. T 363 adopted as the shape of tool to be used. The names of different contestants to be placed in an envelope, and the first one drawn shall decide the first steel to be tested, etc. Every contestant to be furnished with a complete record of each steel tested, said records and reports to be signed by each of the judges. Mr. C. Edwin Search, of Milwaukee, Wis., to be extended an invitation to serve as judge in behalf of the steel men. In case it is not convenient for Mr. Search to serve, Mr. J. B. Barnes, of the Wabash Railroad, to be selected in his stead. That a committee of three, if in the city, should constitute a quorum, and the committee shall meet on August 20 at 2 p. m. to close all entries in the test and such other business as may come before it.

The tests were made on a Putnam lathe driven by a Northern variable speed motor.

RELATION OF WINDOW-AREA TO FLOOR SPACE.

A somewhat informal, though careful, effort has been made at Cornell University to determine a general statement of the relative proportion between window-openings and their position, and the floor-area and the depth of the rooms to be lighted. The data, says *Keith's Magazine*, were intended to apply to the problem of securing an adequate supply of natural light in the lecture-rooms on all ordinary days between 8 a. m. and 5 p. m., under the climatic conditions which prevail in Ithaca, N. Y.

Information was secured which was based on actual experience in six buildings on the Cornell Campus, and referred to rooms lighted from one side only. From the statements submitted by the professors in charge of the work in the several buildings the following data have been compiled regarding sixteen rooms adequately lighted, and nine rooms in which the light is "nearly sufficient."



OTTO GAS ENGINE EXHIBIT AT ST. LOUIS EXPOSITION.

Number of Rooms.	Total Area, Floor. Feet.	Windows. Feet.	Ratio.
Sufficient 16	10,466	2,000	1,000:191
Nearly so 9	5,392	799	1,000:146

Average Depth of Room.	Average Height Window Tops.	Ratio.
22 ft. 1 in.	11 ft. 9 in.	1,000:518
20 ft. 6 in.	10 ft. 2 in.	1,000:495

All these rooms are alike in having unobstructed light; no building stands before the windows.

A peculiar relation which should be observed is that the well-lighted rooms have an average of 654 sq. ft. of floor-area and 22 ft. 1 in. deep, while those whose light is "nearly sufficient" are smaller and shallower, being 599 sq. ft. area and 20 ft. 6 ins. deep.

One explanation of this unexpected result is found in the figures relative to the positions of the windows. In the well-lighted rooms the window-tops average 11 ft. 9 ins. above the floor and 1 ft. 6 ins. below the ceiling; in the other rooms they are 1 ft. 7 ins. nearer the floor and 11 ins. farther from the ceilings.

The conclusions to which this local experience leads are these:

(1) There should be at least 150 ft. of window-space in each 1,000 sq. ft. of floor space in rooms which, in use and location, are similar to those here described and are lighted only from one side.

Therefore an office 15x25 should have at least 56 sq. ft. of

window-space and a class-room 30x40 should have at least 180 sq. ft. of unobstructed lighting surface.

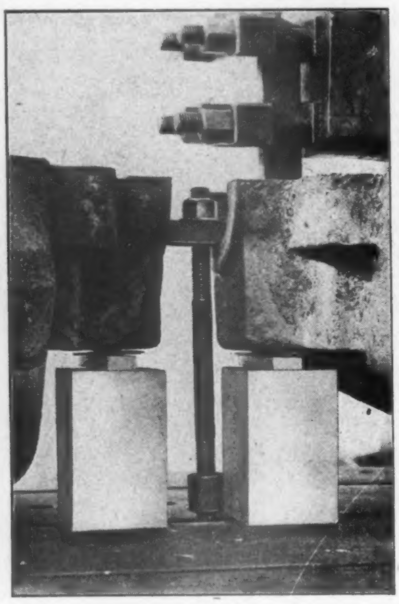
(2) The proportion between the height of the window-tops and the depth of the room lighted should be at least 500 to 1,000, or, in other words, the distance from the floor to the window-tops should be one-half the depth of the room to be lighted.

These figures support the old principle that "top-light" is the best; the nearer the window-tops come to the ceiling the more efficient will be the lighting to be secured from a given surface. Care should be taken that overhanging lintels be not allowed to obstruct the light.

T-BOLT HEADS FOR RAPID CHUCKING.

While the high-speed tool steels have done much to reduce the time of turning out work on machine tools, in many cases as great or greater savings can be made by increasing the facilities for chucking or clamping down work. In railroad shops, where the work is general in character and different classes of work are often handled in the same machine during the course of the day, considerable time is lost in cleaning out T slots, and hunting blocks, clamps, bolts, etc. The T bolt head here described was developed in a large shop, where difficulty was experienced due to breakage of T bolts, the necessity for carrying a number of different lengths in order to meet the various conditions, and where time was often lost due to the necessity of having new bolts of a special length forged. The T bolt heads shown are drop forged from high carbon steel and case hardened, and are practically indestructible. A number of studs of different lengths can be made to fit them at a small expense, and in case of breakage can easily be renewed. The underside of the heads are turned, to present a smooth surface to the slots, to prevent wearing or breaking them out. The shape of the head is such that it is unnecessary to clean out the entire slot in order to use them, and they can be placed after the work is set on the machine. The larger half-tone shows one of Lang's T bolt heads on a 72-in. planer. The bolt had to be of exact length, so as not to interfere with the cutting tool, and the stud was threaded while the work was being leveled, and enough time saved over the time required to make an ordinary T bolt to more than pay for the T bolt head. In many cases work can be clamped through cored holes or slots where it is impossible to get an ordinary T bolt. The heads are made to fit all standard slots, from a No. 0 milling machine to a 20-ft. boring mill, and are tapped from ½ to 1¼ ins. with either U. S. S. V. or Whitworth threads. They are made by the G. R. Lang Company of Cincinnati.

LANG'S T-BOLT HEAD.



APPLICATION OF LANG'S T-BOLT HEAD.

LUBRICATING GREASES.

In a paper on the "Analysis of Lubricating Greases," read before the Pittsburg section of the American Chemical Society, Mr. P. H. Conradson stated that he generally submitted greases to the following tests and analysis which enabled him to form a good idea of the quality and composition.

1. Consistency of the grease. Soft, medium or hard.
2. Color. Dark or light, etc.
3. Odor. Tarry, asphaltic or resinous, etc. Oftimes the odor of the grease gives quite an indication as to the nature of at least some of the materials that may be present, principally tarry matter or rosin oils.
4. Softening point. The temperature at which the grease begins to become soft, when carefully warmed and heated.
5. Incipient melting point. The temperature at which the grease begins to partially melt, oftentimes with separation of the oily or fatty matter from the soap and mineral matter.
6. Melting point. The temperature at which the grease is completely melted.
7. Flashing point. The temperature at which inflammable vapors are given off, indicated by applying a small flame.
8. Burning point. The temperature at which the grease begins to burn, when flame is applied.
9. Note. If the grease foams or swells and spatters during heating it indicates the presence of more or less water.

Some greases when heated to make the above tests, foam and swell much, until the water is driven off, others remain quiet and melt uniformly, others again partly melt at a comparative low temperature, with the separation of the soaps in solid lumps, or the settling out of the mineral matter to the bottom of the vessel.

ANALYSIS OF SAMPLES OF GREASES.

	No. 1.	No. 2.	No. 3.
Color	Dirty Yellow	Dark	Dirty Yellow
Odor	Rosin	....	Rosin
Consistency	Very soft	Hard	Medium
Softening point	....	225 deg. F.	160 deg. F.
Melting point	Flows at 85 deg. F	415 deg. F.	250 deg. F.
Flashing point	385 deg. F.	540 deg. F.	350 deg. F.
Burning point	450 deg. F.	....	400 deg. F.
Soda soaps	....	55.31 per cent.	....
Lime, magnesia soaps	5.68 per cent.	....	13.12 per cent.
Mineral or hydrocarbon oils	91.95 per cent.	32.32 per cent.	84.00 per cent.
Water	2.37 per cent.	14.51 per cent.	2.00 per cent.
Grav. of separated oil	23.5 deg. B.	....	Trace lime
Free mineral matter	....	Little graphite	23.0 deg. B.

Behavior in heating.—Greases foam some. Nos. 2 and 3 have a tendency to separate into oil and lumps of soap.

The mineral oil in No. 2 is a thick, heavy at ordinary temperature, nearly solid, dark colored oil.

Mineral oils in Nos. 1 and 3, yellow colored. These two greases are compounded with rosin oils.

The single-phase motor is the one thing presented at the present time as the solution of the general railway problem. It has all the advantages of the direct-current motor in the variable speeds; it has the advantage of the alternating-current system in the use of any voltage desired, and the variable voltage applied to the motor, and thus adjustable speed, and it also has the advantage of control that can be obtained without sparking. —*B. G. Lamme, International Electrical Congress.*

BOOKS AND PAMPHLETS.

Reinforced Concrete. By A. W. Buel and C. F. Hill. The Engineering News Publishing Company, 220 Broadway, New York. 434 pages. Price, $5.00.

The above book is a timely production and will fill a very real need among American users of reinforced concrete, as it concentrates in one volume many of the recent formulæ dealing with this much-used material, and describes in detail the different forms of construction now in vogue. The work is divided into three sections: Part I, from the pen of Mr. Buel, is entitled "Methods of Calculation," and Parts II and III, by Mr. Hill, are styled respectively "Representative Structures" and "Methods of Construction." In Part I considerable space is given to the methods of development of several of the more familiar formulæ for concrete steel beams, and reports of numerous tests upon both beams and columns are quoted. Methods of treatment of retaining walls, dams, tanks, conduits and chimneys are also given, and one long and very valuable chapter is devoted to arch bridges and their abutments. Part II consists of a careful description of a

large number of examples of actual construction, both in this country and abroad, and covers nearly all the uses to which reinforced concrete has so far been put. Part III is the shortest, but by no means the least valuable, for it gives much practical information concerning methods of handling the material, and of building forms, centres and the like. The text throughout the book is copiously illustrated, and the volume is worthy of a wide circulation not only among engineers and architects, but also concrete contractors.

"CEMENT AGE."—The September number of the *Cement Age* is notable in presenting articles from engineers of the New York Rapid Transit Commission on the use of concrete in the subway. Concrete offers a great advantage in permitting unskilled labor to be substituted for the skilled labor which would be required for brick laying. This had an important bearing upon the cost and celerity of the work on the subway in addition to the advantages of monolithic construction offered by concrete.

STORAGE AIR BRAKE SYSTEM.—The system of storage air brakes used on the cars of the St. Louis Transit Company is described in a pamphlet issued jointly by the Westinghouse Traction Brake Company and the Ingersoll-Sergeant Drill Company. It describes and illustrates the compressors, the storage facilities, the brake and presents tests made in practice.

VALVES.—Special catalogue No. 100 has just been issued by the Crane Company of Chicago describing their very complete line of pop safety valves, water relief valves and boiler trimmings. They have also sent out a small pamphlet illustrating their exhibits in the Machinery Hall and Transportation Building at the St. Louis Exposition.

"A B C" ENGINES.—The American Blower Company of Detroit have just issued the following bulletins: 162 describing their "A B C" type F high-speed vertical engine; 163 describing their type B "A B C" vertical engine with "marine" type frame, and type C which is designed for direct connection to mechanical draft outfits; 164 describing their type I "A B C" horizontal engine.

TRACTIVE POWER CHART.—This chart, 15 by 20 ins. in size, is printed on tough paper and affords a convenient method of quickly finding the tractive power of a locomotive. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 50 cents.

WM. SELLERS & COMPANY, INC.—A pamphlet just issued describes their exhibits at the St. Louis Exposition, which include a 96-in. planer with pneumatic clutches for reversing, universal tool grinding and shaping machines, improved drill grinding machine, their well known improved and self acting injector for railroad and high-class stationary service, the 80,000-lb. traction dynamometer in the Pennsylvania Railroad exhibit, cranes, shafting details, etc.

VARIABLE SPEED MOTORS.—Northern Electrical Manufacturing Company's Bulletin 37 describes and illustrates application of their single voltage variable speed motors to a number of different machine tools. These motors do not require any wiring other than that required by constant speed motors. A Gould & Eberhardt shaper exhibited at St. Louis is driven by one of them which has a speed variation of more than 5 to 1 and is operated from a two-wire single voltage circuit. A characteristic curve of this type of Northern motor shows that the horse-power is practically constant for all speeds.

The Standard Steel Car Company of Pittsburg has just issued a new booklet containing complete descriptive matter, together with a number of handsome illustrations of their two new solid forged, steel equalizer bar trucks for electric railways, manufactured at their works, Butler, Pa. The book is 6 x 9 inches in size and finely printed on plate paper with cover stamped in gold. The illustrations show the new arrangement of joining the journal boxes rigidly to the equalizer bars, and the machine finishing of the journal boxes and bearings. This booklet will prove of great interest to all electric railway managers, and the company will send a copy immediately upon request to their general office, 1127 Frick Building, Pittsburg, Pa. These trucks are now on exhibition at the World's Fair, St. Louis, Transportation Building, Aisle E, Post 45.

CHUCK FOR FLAT DRILLS.—Described in a pamphlet issued by the George R. Rich Manufacturing Company of Chicago. Device is specialy adapted to drill holes 4 ins. or less in length, and is guaranteed to run at a speed four times as fast as a twist drill.

LATHES.—The R. K. Le Blond Machine Tool Company of Cincinnati have just issued a catalogue describing their lathes. The construction is considered in detail and a number of motor applications are shown.

MAINE SPORTS.—In mentioning in a general way the various portions of Maine's territory, starting at Bemis as an egress, one can enter the famous Rangeley and Dead River regions—the Dead River separating them. Here both deer and moose are found, while foxes and game birds are particularly plentiful. Proceeding in the comfortable Pullman cars from Boston, one can go through to Greenville, from where departure may be made for the great surrounding section. Following from the northerly end of Moosehead the west branch of the Penobscot, the entire territory is infested with deer and moose. It becomes the herding ground for the moose in their wandering from Canada. Mount Katahdin, reached by water or land, is a delightful camping ground. The mountain is 5,000 ft. high, and in its thick forests moose seek refuge. From here, by canoe, it is possible to journey to the main line of the Bangor & Aroostook Railroad, the heralded territory. From the stations of this road alone, last year, over 3,786 deer and 232 moose were shipped in the open season. Here one often encounters bears, wildcats, loupcerviers, and woodcock and partridge are found in abundance. Mount Katahdin is easily reached from here by means of Norcross and Stacyville. The newest station of Maine's sporting grounds in that portion reached by the Washington County Railroad. It is a dense wilderness of vast size, and as yet never penetrated except by lumbermen and straggling sportsmen. In portions of New Hampshire and Vermont good sport may be secured, and some sportsmen prefer the wild tracts of New Brunswick and Nova Scotia. In order to get a detailed description of the hunting region, send a two-cent stamp to the General Passenger Department, Boston & Maine Railroad, Boston, for their illustrated booklet, "Fishing and Hunting." Accompanying will be mailed a booklet of the condensed Fish and Game Laws of all Northern New England and Canada.

NOTES.

ERIE HEATING COMPANY.—This company has moved into its new offices at 225 Railway Exchange Building, Chicago, where correspondence should now be addressed instead of 34 West Monroe street.

LOCOMOTIVE APPLIANCE COMPANY.—At a meeting of the board of directors held September 26 the following officers were elected: Mr. Ira C. Hubbell, president; Messrs. W. C. Squire, Clarence N. Howard and J. J. McCarthy, vice-presidents; Mr. J. B. Allfree, consulting engineer; Mr. E. B. Lathrop, treasurer, and W. H. England, secretary.

PAINT FOR STEEL WORK.—Dixon's silica-graphite paint was used to preserve the structural steel work of the new St. Regis Hotel, the new boathouse of the United States Naval Academy at Annapolis, the new Wabash terminal station in Pittsburgh, the North-German Lloyd terminal and other recently completed structures of note in this country.

CROCKER-WHEELER COMPANY.—The Crocker-Wheeler standard railway type electric generators compound wound for 550 volts, used in the Intramural Railway power plant at the St. Louis Exposition, and the engines which drive them are for sale, delivery to be made early in January. Six of the generators are driven by steam engines of different makes and one by a water wheel. Bulletin 49, issued by the above company, describes and illustrates the engines and generators.

NORTHERN ELECTRICAL MANUFACTURING COMPANY.—This company recently shipped to the New York Edison Company a 60-kw. balancing set for its Waterside station and 34 two-wire variable speed field control motors, to be directly coupled to blowers for cooling the transformers at sub-stations. They also shipped 9 small motors to be installed in sub-stations of the Brooklyn Rapid Transit Company. This make a total of 75 Northern motors, aggregating 1,500 h. p., now in use by these two companies.

LINDENTHAL SIDE BEARINGS.—These bearings were described in a paper read read recently by Mr. Gustav Lindenthal before the New York Railroad Club. They have been in successful service for several years. Mr. Charles F. Pierce has been appointed sales agent, with office at 45 Cedar street, New York City.

WARNER & SWASEY COMPANY.—This company has an extensive and well arranged exhibit at the St. Louis Exposition which includes their Nos. 1 and 2 hollow hexagon turret lathes arranged with belt and motor drive; Nos. 1, 2 and 5 turret screw machines, 16-in. forming turret lathe, 16 and 24-in. universal turret lathes, 2-spindle valve milling machine and horizontal boring machine.

B. F. STURTEVANT COMPANY.—The increasing demand for mechanical draft continues, not only in the United States, but in other countries. The power plant for the new shops of the Mexican Central Railway Company, at Aguascalientes, Mexico, contains a Sturtevant induced draft apparatus, consisting of two steel-plate fans, each driven by a Sturtevant vertical engine. Each fan is capable of maintaining a draft pressure in the flue connection of each boiler equal to ¾ of an inch of water when handling all the gases of combustion burning 35,000 lbs. of coal per hour with a flue temperature of 600 degrees Fahr. The ring oiling fan bearings next to the fan are water-jacketed to prevent overheating. A counterbalanced sliding damper permits either fan to be cut off from the flues or both may be operated at the same time. The engines are provided with regulating valves which automatically control the steam pressure.

ALLIS-CHALMERS COMPANY AWARDS.—From the department of publicity of this company the following, concerning the awards at the St. Louis Exposition, has been received: The 5,000 horsepower engine popularly known as the "Big Reliable," and the huge generator built by this company's electrical department—otherwise known as the Bullock Electric Manufacturing Company—each won a grand prize. In the Departmentof Mines and Metallurgy the Allis-Chalmers exhibit was also awarded a grand prize, the highest honor given by the international jurors. Among other features of this mining exhibit, and contributing to the success which won the highest award, are the famous style "K" Gates gyratory rock and ore breakers, the Overstrom concentrating table, the Allis-Chalmers style "A" and "B"' crushing rolls, the Gates ball and tube mills, and the heavy 6-foot Huntington mill, known as the "Anaconda" type, manufactured only by this company. The Bullock Electric Manufacturing Company's grand prize also covered all their alternators, synchronous motors, direct current generators and motors, and rotary convertors. In addition, the Bullock system of multiple-voltage control of motors won a gold medal.

WHAT A CAR CLEANER SHOULD DO.—A passenger car new from the builders or the paint shop is beautiful—but remains so only a few weeks when in service. The varnish is there under the dirt, and the light dirt only can be easily removed. After a year's service the varnish is still good, in fact, it is preserved by the dirt. Then a "car cleaner" is applied, and if the cleaner is of cheap material it is necessary to use force and abrasives in order to remove the dirt. This cleans the car, but it destroys the varnish, leaving a dull, flat surface which will catch the dirt more quickly and hold it more effectively than before. For this reason cleaners have been given up by some roads in favor of water and brushes. A satisfactory car cleaner should remove the dirt quickly without scouring or demanding hard muscular labor. It should leave a polished surface after being well wiped with dry waste and should leave the varnish intact. The cleaner should renew the life, color and elasticity of the varnish, and should leave in the body of the varnish a certain amount of filler to prevent moisture from entering. With such a cleaner the car should return to service in condition to carry no more dirt than when first turned out. Every application of such a cleaner must benefit the varnish by feeding and strengthening its body. Such a cleaner is believed to be available from the Beacon Paint & Varnish Preservative Company, 1313 Vine street, Philadelphia.

Mr. Clement F. Street has been appointed commercial engineer of the Westinghouse Electric & Manufacturing Company to handle work in connection with steam railroads. Mr. Street is well known among railroad men, and is well qualified to take charge of this important branch of the Westinghouse work. He has had a wide experience in the railroad field, gained through connection with many important interests, and his selection by the Westinghouse Electric & Manufacturing Company is a high compliment to his ability as an engineer. Mr. Street's career began in the service of the Buckeye Engine Works, of Salem, Ohio, where he served six years—three years as an apprentice to the machine trade and three years in the drafting room. Leaving this company, he became connected with the Johnston Company, of Johnstown, Pa., where he spent two years as chief draftsman. The next two years were spent in the engineering department of the E. P. Allis Company. He resigned this position to assume one of greater responsibility with the Chicago, Milwaukee & St. Paul Railway. After four years of service with the latter company as chief draftsman in the motive power department, he entered the journalistic field on the staff of the *Railway Review*, of Chicago. While connected with the *Review* he spent the years of 1894 and 1895 traveling around the world as engineer of the Commission World's Transportation of the Field Columbian Museum, of Chicago. Upon his return he made an exhaustive report to the commission upon the railroads of North Africa, Egypt, Ceylon, India, Burmah, Siam, Java, Australia and Japan. Upon retiring from this work he became manager of the railway department of the Dayton Malleable Iron Company, of Dayton, Ohio. His latest field of activity has been with the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, in the capacity of manager of their railway department, which position he has just resigned. Mr. Street has not only devoted many years to careful study of the requirements of railroads, but has thoroughly familiarized himself with actual shop practice as well. He is a member of the American Society of Mechanical Engineers, the Western Railway Club and the Railway Master Mechanics' Association.

The heating and ventilating of large, high studded rooms in passenger terminal stations constitutes a problem in the solution of which practice as applied in buildings involving large auditoriums, may be advantageously considered. A recent example of up-to-date heating and ventilation equipment is that of the new First Church of Christ, Scientist, in New York City. This building is attracting wide attention among architects and engineers because of the completeness of its equipment. It has two 100 h.p. boilers, each of which is sufficient, alone, to supply all the steam needed in the coldest weather, and a coal storage capacity of 200 tons is provided. Two 6 ft. Sturtevant fans, driven by 15 h.p. C. and C. motors, draw air from a point 100 ft. above the ground, and, after forcing it through steam coils in 5 sections, deliver it to a plenum chamber between the ceiling of the basement and the main floor. Fresh, warm air is delivered from here through ducts to registers at the end of each seat and in the side aisles. Hollow construction is also applied to the galleries and a uniform supply delivered through 200 registers. In addition to this system, direct radiators are placed immediately under the sills of all the windows; these are for the purpose of neutralizing the cold down draft which would otherwise come from the windows. Two large ornamental exhaust registers are placed in the ceiling of the auditorium, through which a 6 ft. Blackman exhaust fan draws air for discharge above the roof. The space between the arched ceiling and the roof serves as an exhaust duct. With these facilities the entire volume of air is changed four times every hour. The upper floors are warmed and ventilated in the same way, but the primary coils for direct radiators are supplemented in some cases by superheaters at the bases of the flues which conduct the air to the remote parts of the building. All of the controlling dampers are operated by chains leading to the engine room. Direct radiation is used in vestibules, stair and passage ways. A Johnson thermostatic system controls the temperature. The engine room is provided with two Worthington steam pumps, a self-acting house pump, two Loomis-Manning filters, three pumps for the drainage sumps, an Otis hydraulic ash hoist, switchboard and a workshop with a lathe and facilities for machinery repairs. Three electric elevators were furnished by the Marine Engine & Machine Company. Each 20-passenger elevator is driven by a 35 h.p. Crocker-Wheeler motor and a small 6 passenger elevator at the 96th street entrance is driven by a 25 h.p. motor of the same type, the elevator speed being 300 ft. per minute. A Sturtevant fan, driven by a General Electric motor through a regulating rheostat, supplies air for the organ. All the electric power is taken from the Edison mains.
